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Could Hogs Be Sold by Carcass Weight and Grade in the United States?

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AGRICULTURAL ECONOMICS SUBSECTION
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SUMMARY

Detailed statistical investigation indicates that commercial butcher hogs are bought on too nearly a "flat price" basis; the differences between the values of different lots of butcher hogs are greater than the differences between the prices paid for them. Within each weight class the variations in value may be as much as five times as great as the variations in prices paid. The correlation between values and prices, lot by lot within each weight class, is rather low. It ranged from +.34 to +.56 in the cases studied.

The reason for the inaccuracy of the prices paid for hogs on the live weight basis is two-fold: (1) It is difficult for the buyer to detect value differences accurately on the hoof, no matter how experienced he is, and (2) it is even more difficult for farmers to do so. Accordingly farmers are reluctant to accept discounts for low-grade hogs. It is difficult for the buyer to detect value differences accurately in the first place and difficult for him to register those differences in proper premiums and discounts. He therefore pays close to the average for all but the obviously defective hogs in each weight range. Both of these reasons stem from the fundamental impossibility of appraising hog values accurately on the hoof.

THE CARCASS BASIS OF SALE

Many of the shortcomings of the live weight system of sale would disappear if hogs were sold by carcass weight and grade. In 1938 farmers in Canada sold 40 percent of their commercial hogs on the carcass value basis. The various physical problems involved have been solved under Canadian commercial conditions. They are:

(1) *Positive identification* — obtained by tattooing the live hogs on the shoulder with a high speed rotary head tattooing iron and indelible ink.

(2) *Accurate carcass weights*—registered by automatic electric recording scales on the carcass rail in the plant.

(3) *Accurate and impartial grading*—performed by a government carcass grader stationed beside the carcass rail where it leaves the slaughtering floor.

(4) *Impartial and speedy settlement*—secured by the government grader or his assistants filling out the settlement sheets for each farmer, the plant office getting the checks in the mail the day the hogs are slaughtered.

(5) *Cost*—The extra cost of selling hogs on the carcass basis is estimated by Canadian authorities to be about 1 cent per 100 pounds live weight.

There is considerable evidence that the methods worked out by the Canadians to handle their physical problems could be adapted to conditions in the United States.

ECONOMIC PROBLEMS

Certain economic problems, however, still await solution before the carcass method would work smoothly here. One of them is the problem of working out adequate carcass grade specifications for

United States conditions. Objective grade specifications—that is, specifications that run in terms of inches, pounds, etc., rather than in such subjective words as "long," "plump," etc.—have been used successfully in Denmark, Great Britain and Canada. Their use promotes uniformity and efficiency in grading, gives farmers definite marks or objectives at which to aim and reduces disputes over grading. Suggestions are made in this bulletin for outlining a preliminary set of objective carcass grade specifications suited to conditions in the United States.

The problem of determining proper price differentials for the different grades waits upon the setting up of the grade specifications. It is not peculiar to the carcass basis of sale. It exists under the present live weight system but is partly obscured in the crudity of that system.

CONCLUSION

As far as can be determined, packers would pay out about the same amount of money for a given year's supply of hogs under the carcass system of sale as they would under the present live weight system. If the carcass system were adopted, the benefits to hog producers would come not from any increase in the total amount of money for a given run of hogs but from three other sources:

(1) The money paid for the hogs would be distributed more equitably among the different hog producers than at present. Each producer would get more nearly what his particular hogs were worth. The producer of high-yielding and high-grade hogs would get more than under the present live weight system, and the producer of low-yielding and low-grade hogs would get less.

(2) Under the stimulus of this incentive for raising high-yielding and high-grade hogs, with the passage of time hog producers would bring in hogs of higher average grade and yield than under the present system. A year's run of these higher grade hogs would be worth more to packers, and would enable them to pay more money to hog producers.

(3) The carcass basis of sale would remove any incentive for "filling" hogs, and hog producers would save the cost of the feed now wasted on this practice.

Shifting the basis of sale from the live hog to the carcass and putting the carcass grading in government hands would involve the minimum disturbance of existing livestock trade practices. It would simply mean moving the scales inside the plant and putting a government grader beside them. This would (1) protect farmers and others dealing with more experienced hog buyers, (2) remove the need for "higgling and bargaining" over the yield and grade of the carcass and (3) provide a uniform language for price quotations. By thus providing a clear, uniform and accurate language for buyers and sellers it would raise the plane of competition for hogs.

Could Hogs Be Sold by Carcass Weight and Grade In the United States?[1]

By Geoffrey Shepherd, Fred J. Beard and Arval Erickson[2]

Hogs are sold on three different bases in different parts of the world. In some countries they are sold at so much per head; in others they are sold at so much per 100 pounds, the common practice in the United States; in still others they are sold at so much per 100 pounds carcass weight.

The first method—sale by the head—is the oldest, the simplest and the most inaccurate of the three. It necessitates estimating not only the grade of the carcass but also the live weight and dressing percentage (or yield) of the hog. This system was used almost universally in England until recent times and is still the prevailing method in France.

The second system, selling by the 100 pounds live weight, is the prevalent method in the United States. It is a more accurate method than sale by the head. The weight of the hog is determined by scales, and the buyers and sellers have to estimate only the dressing percentage (or yield) and grade of the carcass.

The third method, sale by carcass weight and grade, is the most accurate of the three. It is the basis on which all Danish hogs have been sold for many years. Strictly speaking, the Danes do not sell hogs; they sell hog carcasses. The carcass system takes most of the guesswork out of hog selling, because after the hog is slaughtered the carcass can be weighed and graded more accurately than a live hog.

In 1931 the British, under their nation-wide Pigs Marketing Scheme, shifted over at one stroke from their previous method of sale by the head to sale by carcass weight and grade. They omitted entirely the intermediary stage of sale by the 100 pounds live weight. Today, all bacon hogs in Great Britain are sold by carcass weight and grade.

But it is not necessary to go so far from home to see the carcass basis in operation. It is being put into practice just across our northern border in Canada.

Until recently the bulk of the hogs in Canada were sold by the 100 pounds live weight, the same as in the United States. But in July, 1934, the carcass basis of sale was introduced at a plant in Peterboro, Ontario. The system found favor there and spread to other parts of eastern Canada, until in 1936 over 400,000 hogs were

[1] Project 518 of the Iowa Agricultural Experiment Station.

[2] The authors wish to express their appreciation for the cooperation given by the officials of the packing plants where most of the research reported in this bulletin was conducted.

slaughtered on that basis. That was 13 percent of the total Dominion inspected slaughter. In the latter part of 1936 the system was extended to western Canada. With the method available over the whole of Canada, its use increased rapidly. In 1937 about a million hogs were slaughtered on the carcass basis; in 1938 about a million and a third, which was 40 percent of the total Dominion inspected slaughter. For the first 31 weeks of 1939 the percentage was 49. The percentages of hogs slaughtered on the carcass basis since 1934 are shown in fig. 1.

A system of selling hogs that has had so long a record in Denmark, that was adopted at one sweep for all bacon hogs in Great Britain and is voluntarily being adopted rapidly by farmers in Canada, merits the attention of anyone who is interested in livestock marketing in the United States. How does the carcass basis of sale work out? What are its advantages, and what are its drawbacks? Would it be a desirable system in the United States? Would it be practical here?

The first two of these questions have been answered in some detail in a previous publication.[3] The last two questions, as to the desirability and feasibility of the method in the United States, are the subjects of the present report.

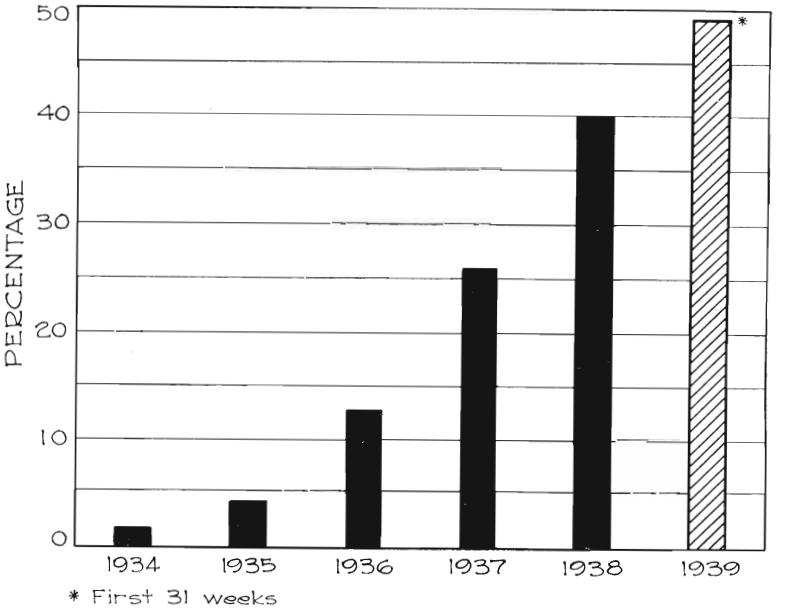

Fig. 1. Percentages of hogs sold on the carcass basis in Canada, 1934 to 1939.

[3] Shepherd, Geoffrey. Livestock marketing methods in Denmark, Great Britain and Canada. Iowa Agr. Exp. Sta., Bul. 353. 1937.

DEFINITION OF TERMS

In this bulletin frequent use is made of some technical terms. They are defined as follows:

Cut-out value. This is the value of the hog, determined by "how the carcass cuts out," i.e., by the weight, grade, price and value of the different cuts in the carcass. It should include an allowance for offal, blood, hair, etc.; but since these are fairly constant and not very high in value, they are usually assigned a constant credit and are therefore not included in this study, which deals with the variations in cut-out values, not with their absolute amounts. Cut-out values may refer to value per hog but usually refer to value per 100 pounds live weight, or sometimes value per 100 pounds carcass weight.

Carcass yield. This means yield of carcass. It means the same thing as dressing percentage. If the carcass from a 200-pound hog weighs 150 pounds, the yield or dressing percentage of the hog is 75 percent.

Coefficient of variation. This is the standard deviation divided by the mean of the series. It expresses the variation in a series of items in one figure, in percentage terms. This permits direct comparison with other series even though they are expressed in different units from the first series.

DESIRABILITY OF CARCASS SELLING

The question as to the desirability (or otherwise) of carcass selling in the United States turns upon the accuracy of the existing live weight basis of sale. If the present system is accurate, there is no need to change it for any other.

The standard or measure of accuracy is the cut-out value of the hog, that is, the total value of the diferent cuts of meat, scraps, by-products, etc., into which the carcass is made. Many people believe that there is not much difference between the cut-out values of different hogs in the same weight class. Hog buyers are likely to comment, as the hogs come into the yards in years when there is plenty of corn, "Look at them. They're all the same." Price quotations lend support to this opinion; they generally run in such terms as "Good to Choice Butcher Hogs, 200-240 pounds, $8 to $8.20." The range of prices quoted is usually only 15 or 20 cents. The bulk of the hogs grade Good to Choice and are usually bought within this narrow price range.

The first thing required is to test this belief and determine how uniform the cut-out values of different hogs in the same weight class actually are. The results of two such tests are reported below.

CUT-OUT VALUES OF INDIVIDUAL HOGS

EXPERIMENT STATION HOGS

In the course of the meats research and teaching at Iowa State College, about 150 Experiment Station hogs annually are slaughtered and cut up. The carcasses and cuts made from these hogs are weighed and measured after they have cooled in the cooler. The weight data can then be used for computing individual carcass cut-out values.

These hogs are fairly representative of ordinary commercial slaughter hogs, except that they are more uniform. There are two reasons for this uniformity: (1) In order to reduce the disturbing effect of animal heterogeneity upon feeding and other experimental results an attempt has been made during the past 10 years to breed up as uniform hogs as possible; (2) from these relatively uniform hogs, one breed, Poland China, was chosen in order to avoid complicating the study with differences resulting from different breeds. For these two reasons, the group is considerably more uniform than representative runs of commercial hogs.

One hundred of the carcasses from these hogs were taken as the basis for the test. The hogs from which these carcasses were taken all weighed between 220 and 230 pounds, and they all graded Good to Choice. They were all cut and trimmed uniformly in the meats laboratory by the same man (Prof. Fred J. Beard) into standard cuts. The prices used in computing the cut-out values were taken directly from the "Chicago Provision Markets" and "Wholesale Dressed Meat Prices" as reported by the National Provisioner. The details of the value-computing procedure are given in the Appendix.

The cut-out values per 100 pounds live weight, computed with the use of prices in the second week in December, 1937, show a considerable amount of variation or dispersion about the average. The extent and nature of this dispersion are shown in fig. 2a. This figure shows that the cut-out values ranged from $8.40 per 100 pounds to $9.40.

This dispersion can be measured and shown in one statistical coefficient, the coefficient of variation (the standard deviation divided by the mean). This coefficient for these data was found to be 2.4.

One important reason for this dispersion in values is the dispersion in carcass yields. The dispersion of these yields is shown in fig. 2b. The yields range from 73 percent to 82 percent.

The high correlation between yield and cut-out value per 100 pounds live weight is shown in fig. 3a. In this figure the cut-out value of each carcass is plotted against the yield per 100 pounds live weight. The correlation between the two is represented by the coefficient +.85.

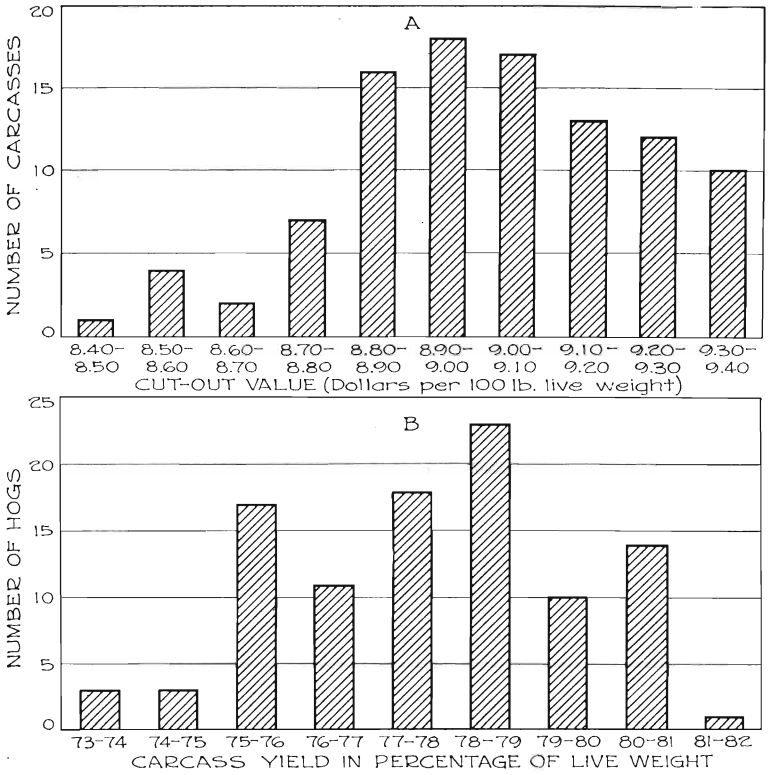

Fig. 2. Frequency distribution of (a) the cut-out values and (b) the yields of 100 hog carcasses.

The figure shows how closely cut-out value per 100 pounds live weight is related to yield. It is clear from fig. 3a and from the large size of the correlation coefficient that one of the chief reasons why hogs of the same live weight differ in cut-out value is that they differ in yield, i.e., in the weight of the carcass.

Figure 3a also shows, however, that differences in yield explain only a part of the differences in cut-out value. If differences in yield explained all of the differences in cut-out value, the dots in fig. 3a would all fall right on the line running diagonally across the figure. But the scatter of the dots about the line in fig. 3a is considerable; it is in fact almost half as great as the total scatter of the dots from the average cut-out value, $9, if the influence of yield is ignored.

Evidently the yield (the weight of the carcass per 100 pounds of live hog) is only one of the things that determine the value of

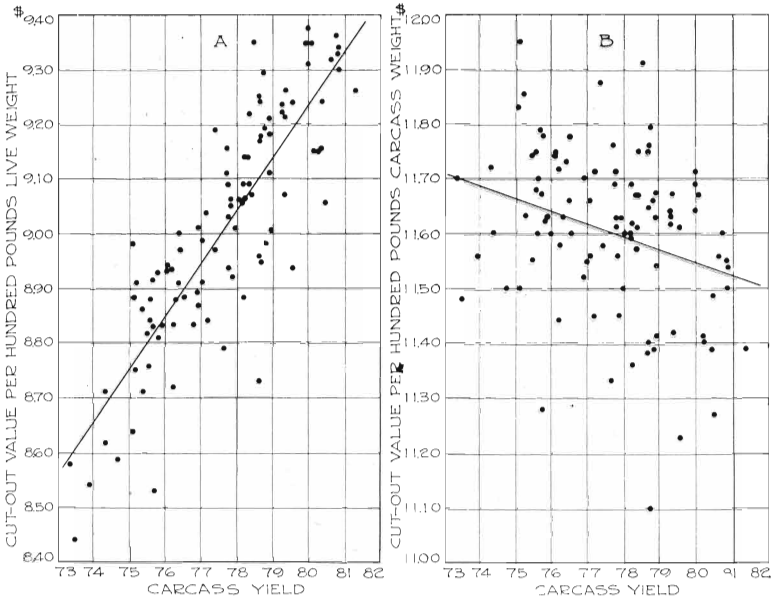

Fig. 3. Relation between the carcass yield and the cut-out value per 100 pounds (a) live weight and (b) carcass weight.

a carcass per 100 pounds live weight. The other thing is the make-up (grade) of the carcass itself. The effect of this make-up can be shown by measuring the dispersion of the values per 100 pounds *carcass* weight. This is shown in fig. 3b. It is also shown by the scatter of the dots about the diagonal line in fig. 3a.

The dispersion of these values per 100 pounds carcass weight is similar to that of the values per 100 pounds live weight, but it is only about half as great. The coefficient of variation for the carcass weight values is only 1.3 compared with 2.4 for the live weight values. Other more technical calculations based on the size of the correlation coefficient lead to the same conclusion—that yield and grade are about equally important in determining cut-out value.

When these carcass weight values are plotted against yields, a slight negative correlation (-0.31) is revealed. This is shown in fig. 3b. This means that the heavier yield carcasses have some tendency to be worth a little less per pound than the lower yield carcasses. The effect of this upon value per 100 pounds live weight, however, is much more than offset by the direct effect of yield, as shown in the previous chart (3a) where cut-out values per 100 pounds live weight were plotted against yields.

How much more valuable are the 50 highest value hogs than the 50 lowest value hogs in this sample? The answer depends upon

the time of year and upon the year itself. Prices fluctuate continually. If December, 1937, prices are used, for example, the difference between the values of the two 50-hog groups probably would not be the same as if July, 1938, prices were used, nor the same as if December, 1938, prices were used.

Several sets of individual cut-out values were therefore computed, using prices as of different months and years. In each case, after the individual cut-out values were computed, the carcass values per 100 pounds live weight were arrayed in order of value, and the whole series cut into halves (the 50 highest values in one half and the 50 lowest values in the other). The average value of each 50 carcasses was then computed and the two average values compared.

It was found that when prices were used as of December, 1937, the difference between the two average values was 34 cents. When July, 1938, prices were used, the difference between the two average values was 62 cents. And when December, 1938, prices were used, the difference was 49 cents.

COMMERCIAL PACKING PLANT HOGS

An attempt was made to check these results by a similar study under commercial packing plant conditions. The attempt was abandoned, however, because of the difficulty of getting individual cut-out values in a packing plant.

It was possible to get some data concerning individual *yields* of hogs from a study of individual yields made in a large packing plant a few years ago. Analysis of the records showed that the coefficient of variation of the yields of 190 representative Good to Choice 220 to 239-pound individual hogs was 3.5. This is nearly 50 percent higher than the corresponding figure (2.4) for the individual Experiment Station slaughtered hogs. This indicates that the Experiment Station test hogs were only two-thirds as heterogenous as everyday commercial hogs; the data from the Experiment Station hogs therefore understate the variation existing in commercial hogs.

Further study of packing house carcasses shows the variation that exists in the make-up of the carcasses, in addition to the variation in carcass yields. In 1938 several hundred individual Choice grade carcasses were selected in a large middle western packing plant and their wholesale cuts weighed. The data were then sorted by carcass weights; there were for example 20 carcasses weighing 140 pounds each, 11 weighing 131 pounds, and so on, as shown in table 1. Within each carcass weight, the weights of the wholesale cuts varied considerably. The weighted average coefficients of variation of the hams, loins and bellies all exceeded 7. In several cases the heaviest cut was more than one-third heavier than the lightest cut from another carcass of the same weight: in some cases, almost one-half heavier.

The actual range of ham, loin and belly weights within the 137-

TABLE 1. VARIATION IN WEIGHT OF HAMS, LOINS AND BELLIES FROM CARCASSES OF IDENTICAL WEIGHTS.

		Hams		Loins		Bellies	
Weight of carcass	Number of carcasses	Coefficient of variation	Percentage heaviest ham was of lightest ham	Coefficient of variation	Percentage heaviest loin was of lightest loin	Coefficient of variation	Percentage heaviest bellies were of lightest bellies
130	20	7.61	135.0	6.83	130.3	8.07	132.5
131	11	4.56	115.0	6.46	125.0	4.85	117.2
132	12	6.15	123.2	9.61	145.0	6.90	127.2
133	6	7.97	121.1	11.59	131.9	11.01	146.0
143	5	4.68	111.7	5.91	115.2	5.97	118.2
135	24	8.57	148.1	7.59	134.8	8.56	141.2
136	7	7.27	125.3	4.40	114.3	5.92	117.4
137	14	8.28	134.1	6.26	121.1	7.18	132.6
138	6	7.77	123.6	4.08	110.7	6.77	121.3
139	7	5.10	114.6	6.86	110.5	6.68	118.1
Weighted av. of the coefficients of variation		7.18		7.10		7.38	

TABLE 2. WEIGHTS OF INDIVIDUAL HAMS, BACONS AND BELLIES IN THE 137-POUND CARCASS WEIGHT CLASS.

Hams	Loins	Bellies
22.00	21.50	17.75
22.50	23.75	17.75
22.50	24.00	18.00
23.00	24.25	18.25
23.75	24.25	19.00
24.75	24.25	19.25
24.75	24.50	19.25
25.50	24.75	19.50
26.00	25.25	20.00
26.25	25.50	20.00
26.25	25.75	20.50
26.25	26.25	21.00
26.50	28.25	21.00
29.50	28.50	21.25

pound carcass-weight class is shown in table 2. There were 14 carcasses in this group, the coefficients of variation for the group averaging 7.24 (the average for all the groups shown in table 1 is 7.22).

ACCURACY OF PRICES PAID FOR HOGS

Different hogs differ considerably in yield, carcass grade and cut-out value. How accurately are these differences reflected in the prices paid for different lots of hogs?

The question is not whether the packer pays an amount equal to the cut-out value of the entire run of hogs (less processing costs) but whether the payment for each lot is equal to its cut-out value. Different lots of hogs have different cut-out values. If these different cut-out values of different lots of hogs are accurately reflected in the prices paid for those lots of hogs, then the existing live-weight system is accurate. If there are wide and irregular differences between the two, then it is not.

This question requires investigation in an every-day commercial packing plant—preferably in several plants—operating in the regular way, so as to reflect actual commercial practices. The research procedure to be followed appears, on the face of it, to be relatively simple. A representative sample of the lots of hogs bought at the plant would be taken, and in each case the number of hogs, their live weights, their grade and the price per 100 pounds would be recorded. The lots would then be followed through the plant, being identified by tattoo mark, or some other means, and their cut-out values determined. For each lot the two amounts—the amount of money paid for the lot and the total cut-out value of the lot—could then be compared. If the two amounts bore a consistent relation to each other, from lot to lot, the existing live weight method of sale would be proved accurate.

This procedure sounds simple, but in actual practice it is diffi-

cult. A hog is a complicated package of merchandise, and ascertaining its cut-out value under commercial conditions in a packing plant operating at full speed is an expensive job. The whole cutting floor gang of 100 or more men has to be stopped for a 10-minute clean-up after each test lot has been run through, so that all the cuts and scraps may be gathered, weighed and recorded. Then each cut and kind of scrap must be weighed and returned to the regular chutes. Packers estimate that tests of this sort cost about $1 a minute. Accordingly, the number of tests has to be held down to a small figure. This is unfortunate, since hogs are classified in ordinary buying practice into a number of classes, with several grades in each class, so that a fairly large number of tests (one or two hundred) would be needed to cover each class and grade adequately.

The procedure can be simplified, however, by carrying it only part way through—only as far as the carcasses, not clear through to the cuts. Each lot can be followed through to the point where the carcasses are taken out of the coolers, just before they reach the cutting floor. At that point the carcasses can be weighed and graded. The cut-out value of each carcass can then be estimated on the basis of these weights and grades. In fact, that is what a carcass grade is—a value grade, a value estimate. This carcass grade and weight can be used as an estimate of the cut-out value.

This was the form of procedure that was finally adopted after some preliminary exploratory work. The investigation was conducted in one of the largest packing plants in the Middle West. The results are given below.

PRICES BY WEIGHTS

Different lots of hogs differ so much in value that hog price quotations divide hogs into several market classes—butcher hogs, packing sows, stags, etc. The principal class, of course, is butcher hogs, which ordinarily constitute over 85 percent of the total run. The present investigation is focused upon this main class, butcher hogs.

Within the butcher class, hogs differ in value per 100 pounds because of their different weights. Grade for grade a 200-pound hog is generally (though not always) worth more per 100 pounds than a 300-pound hog. Accordingly, hog prices are quoted by weights. These weights are generally expressed in 20-pound weight ranges, although the lighter weights may be quoted in 10-pound ranges and the heavier weights in wider ranges than 20 pounds. A typical set of hog price quotations at the plant where the research work for this section was done and at the time it was done is given in table 3. Shortly after that time two changes were made in the quotation and buying system at this plant. The buyers paid high or low prices (within the range of prices quoted) not according to

TABLE 3. TYPICAL SET OF BUTCHER HOG PRICE QUOTATIONS.

March 27, 1937.

We paid the following prices for good and choice truck hogs today:

	Range	
Light weight	140-150	7.60 to 7.90
Light weight	150-160	8.05 to 8.35
Light weight	160-170	8.85 to 9.25
Light weight	170-180	9.15 to 9.45
Light weight	180-200	9.55 to 9.85
Medium weight	200-220)	
Heavy weight	220-250)	9.75 to 10.05
Heavy weight	250-270)	
Heavy weight	270-290)	
Heavy weight	290-325	9.65 to 9.95
Heavy weight	325-350	9.55 to 9.85
Heavy weight	350-400	9.45 to 9.75
Packing sows	275-350	9.35 to 9.65
Packing sows	350-425	9.25 to 9.55
Packing sows	550 up	8.65 to 8.95
Stags (no dockage)		7.70 to 8.00
Sltr. pigs		5.65 to 5.95

NOTE: The above prices represent the range for good and choice truck hogs from nearby and extreme distant points. The left hand column represents the price for nearby truck hogs and the right hand column for extreme long-haul truck hogs.
Medium and cull hogs will be priced according to their killing value.
Thin unfinished hogs will be sharply discounted.

the distance the hogs had been trucked in, as described in the note at the foot of the quotation, but according to the grade and condition of the hogs regardless of distance. They also quoted a narrow range of prices within the wide range originally used.

The conclusions reached in the following section, therefore, relate to the accuracy of the buying system before these changes were made. Some time after the changes were made an additional study was conducted on a smaller scale. It is reported later in this bulletin. The results of the second study were similar to those of the first, but the sample was too small to show whether or how much the change improved the accuracy of the buying.

Since it was found not practical to make numerous cut-out value tests, there was no way of knowing whether the different prices quoted for different weights accurately reflect the average values of the hogs in each of the different weights. That is, it could not be determined whether the prices paid for light, medium and heavy weight hogs correspond with light, medium and heavy weight cut-out values; it was simply assumed that they did. For example, it was assumed that in this case the average 180 to 200-pound hogs were worth 35 cents per 100 pounds less than the average 200 to 220-pound hogs, in line with the prices quoted for those two-weight ranges in table 3. The investigation was confined to the accuracy of the buying within each of the several weight ranges.

Within any given weight range, hogs differ in value for two reasons—differences in dressing percentage (or yield, in packer parlance) and differences in grade. This is only another way of saying that the value of a hog depends upon two things—upon the

quantity and the *quality* (or more accurately, *grade*) of the meat that can be made from it.

The effect of differences in yields can be measured objectively and accurately. One lot of hogs, for example, may yield 67 percent and another 70 percent; the second lot of hogs in that case will be worth 70/67x100=104.5 percent of the value of the first lot[4]. That is, it will be worth 4.5 percent more than the first. If hogs are selling at $8 per 100 pounds live weight, then the second lot of hogs is worth 36 cents per 100 pounds more than the first.

The effect of differences in grade upon value is more difficult to ascertain accurately. Two lots of hogs may have identical yields, but they may differ considerably in cut-out value because of differences in grade. One carcass may weigh the same as another, but if one grades No. 1 and the other No. 2 or No. 3, the No. 1 carcass will be worth more than the other.

These two factors, yield and grade, will be dealt with separately, yield first.

EFFECT OF DISTANCE TRUCKED IN UPON THE PRICE OF HOGS

The buyers at the plant where this part of the investigation was conducted endeavored to take differences in yield into account in the prices they paid by paying (within the quoted 30-cent price range) chiefly according to the distance the hogs had been shipped in. This was stated at the foot of their price quotations, as shown in table 3. They paid at or near the top of the range for distant hogs and at or near the bottom for nearby hogs. The presumption was that the more distant hogs, having been on the road for a fairly long time, had shrunk more than the nearby hogs; they were accordingly likely to yield higher than nearby hogs.

The way this price policy worked out is shown in fig. 4. In this figure, distance from the plant is plotted along the bottom[5], and not the price, because that changed from day to day, but the difference between the price and the top of the price range quoted for that weight, is plotted down the side. The heavy black line across the chart represents the top of the price range quoted for each weight class. Thus, if the quoted price range for 200 to 220-pound hogs was $10 to $10.30, and a certain lot was trucked in from a distance of 50 miles and sold for $10.30, that price would be plotted on the heavy black line. If it had sold for $10.25, it would be plotted 5 cents below the heavy black line.

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[4] Minus a small correction because of the slight negative correlation between yield and grade.

[5] The distances shown were ascertained by noting the addresses of the men who owned the hogs, and computing the distance between that town and the plant. The farmer may have lived several miles closer to or farther away from the plant than his town. The distances given here, therefore, are only approximate.

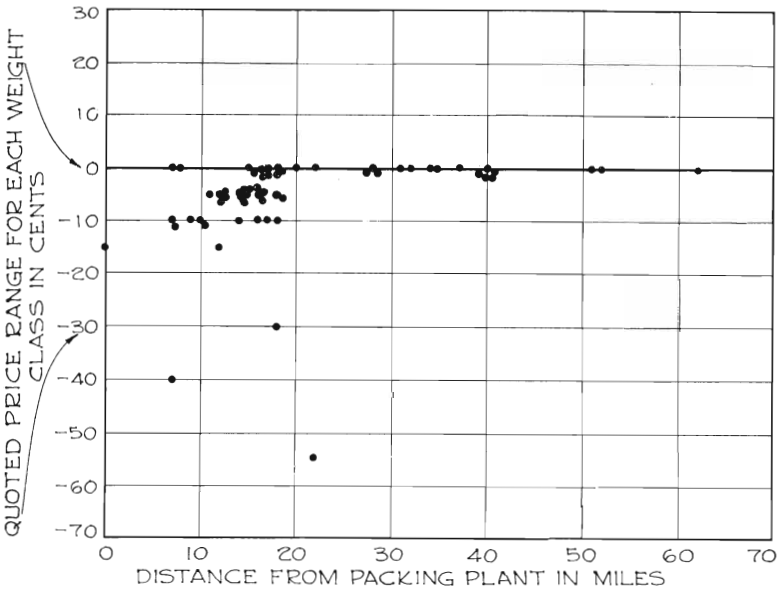

Fig. 4. Relation between the price paid for hogs and the distance the hogs were trucked in.

The chart shows that, in general, up to a distance of about 20 miles, the greater the distance that hogs were trucked in, the higher the price paid. Beyond that distance top prices were paid for all hogs. In 3 of the 60 cases the hogs were not Good to Choice grade and were accordingly discounted as much as 50 cents per 100 pounds. But the bulk of the lots (57 of the 60, or 95 percent)[6] were bought, at any given distance, within a price range relative to the average price quoted for that weight, of about 10 cents per 100 pounds. If shrink is closely associated with distance trucked in, the buying policy followed here would reflect differences in shrink with some accuracy.

EFFECT OF DISTANCE TRUCKED IN UPON THE YIELD OF HOGS

How close is the relation between the yield of hogs and the distance they are trucked in to market?

A statistical answer to this question is shown in fig. 5. This is similar to fig. 4, except that the yields of the different lots of hogs are plotted up and down the side, instead of the prices that are plotted in fig. 4.

In the chart showing prices (fig. 4) the price of each lot is plot-

[6] This percentage corresponds with the percentage existing in the actual runs of butcher hogs at the plant when the test was being made. See later sections of this report.

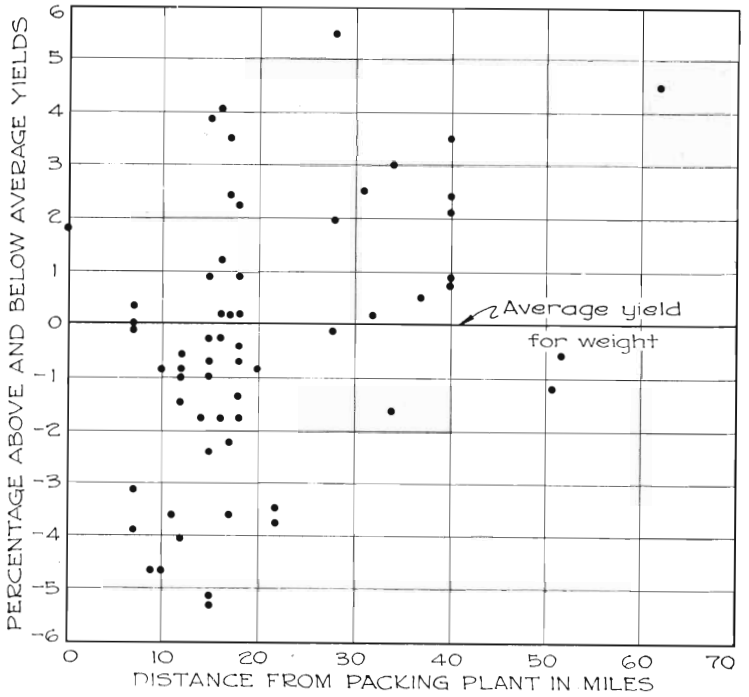

Fig. 5. Relation between the carcass yield and the distance the hogs were trucked in.

ted as so much below the top of the price range quoted for that weight of hog. Similarly in this yield chart (fig. 5) the yield is plotted as so much above or below the average yield for that weight of hog. This is necessary because heavy hogs average higher yields than light hogs, as discussed in detail later in this bulletin.

Fig. 5 shows that the more distant hogs do have some tendency to dress out higher than the nearby hogs, but the relation between distance and yield is not very close.[7] Comparison of fig. 5 with fig. 4 shows further that the variations in yields are much greater than the variations in prices paid. This is especially true of the hogs from nearby points. The amount of variation in each series can be compared visually, by comparing the two charts, since the vertical scales are adjusted so that the vertical readings are directly comparable.

The price quotations shown in table 3 are for Good to Choice grade, a broad grade that ordinarily covers 80 to 90 percent of the

[7] This agrees with the results of another study, where no clear relation was found between shrink and time in transit, up to about 20 hours enroute. See Bjorka, Knute, Shrinkage and dressing yields of hogs. U. S. Dept. Agr., Tech. Bul. 621, p. 6. 1938.

butcher hogs.[8] A few of the lots (in this case, 3 lots out of 60) did not make the grade and were classed as Medium or Common. They were accordingly discounted up to as much as 50 cents per 100 pounds. These were the lots which ranged near the bottom of fig. 4.

These three lots were discounted for their low grade. If that were the only reason, they could be removed from the present section, which deals only with yields, and discussed in the section that deals with grade. Yet yield is associated with grade, so one cannot say that these lots were discounted for their low grade only. Perhaps the best way to handle the matter is to analyze the 57 lots which fell in the Good to Choice grade first and then analyze the three low-grade lots.

By the use of simple statistical methods, each chart (fig. 4 and fig. 5) can be reduced to one figure, and the two figures then compared. Computation shows that the coefficient of variation of the prices paid for the 57 Good to Choice lots is 0.45. The coefficient of variation of the 57 *yields* was 2.5. The variation of the yields, therefore, is 5.5 times greater than the variation of the prices.

The average variation of the yields found in this study apparently represents the general situation at other plants as well; it agrees with the results found by another investigator who analyzed the records of 1,872,287 hogs bought direct and slaughtered in 14 Middle Western packing plants[9]. He found that the variation in the yields of hogs by 10-pound groups from 180 to 259 pounds live weight averaged 2.3 in the winter season and 2.6 in the spring. The work in the present study was done during the winter and spring, and the result, 2.5, is almost exactly the same as the average of his results for the two seasons.

Since the coefficient of variation of the prices paid for hogs (from the average for each weight range) in the present study was only 0.45, it is evident that the range of prices paid was too narrow. Instead of being only 10 cents wide (twice 4.5 divided by the average price of the hogs, $9.37) it should have been 55 cents wide, if differences in yields are to be recognized by corresponding differences in price. The hogs were bought on too nearly a "flat price" basis. There were good reasons for this, as we shall see later.

THE BUYER'S BATTING AVERAGE

A second question now arises. How accurate were the buyers? Within the narrow 10-cent price range, did they pay top prices for the high-yielding hogs, medium prices for the medium-yielding hogs and low prices for the low-yielding hogs?

[8] Some confusion arises from the fact that the hogs were bought on the basis of the live weight grades Choice, Good, Medium and Common, while the carcasses were graded for the purposes of this research project, No. 1, No. 2, No. 3 and No. 4. The two sets of grades, however, correspond approximately.

[9] Bjorka, Knute, op. cit., p. 20.

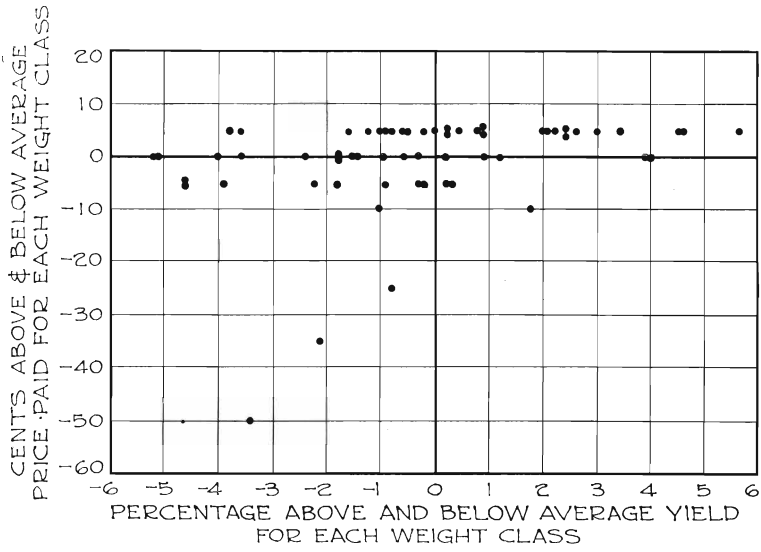

Fig. 6. Relation between the price paid for hogs and their carcass yield.

This question is answered in fig. 6. In this figure each lot is represented by one dot, and the position of the dot on the chart shows the price paid for the lot (as so much above or below the average price paid for hogs of that weight) and the yield (as so much above or below the average yield for that weight).

If the buyer estimated the yield of each lot accurately and paid more or less exactly in accordance with the yields (that is, if the correlation between yields and prices were high), the dots in fig. 6 would fall closely about a line with a positive slope (upward and to the right). If there were very little correlation between yields and prices, the dots would fall either indiscriminately all over the chart, or along a horizontal or vertical line.

Figure 6 shows that the buyer's batting average was not high. The correlation between yields and prices is only +0.34. Even this amount of correlation is due partly to the three lots of hogs that graded Medium and were discounted for their low grades.[10]

The vertical and horzontial scales in this chart are directly comparable, so the chart contrasts the wide dispersion of the yields with the narrow dispersion of the prices paid. The scatter from side to side is several times wider than the scatter up and down.

This correlation test does not take into account differences in grade within the broad Good to Choice grade. The buyer may oc-

[10] For the number of lots in this sample, a figure below 0.25 is considered to have no statistical significance; it may have resulted entirely from chance. Snedecor, G. W., Statistical methods, Table 72, p. 133, Collegiate Press, Inc., Ames Iowa. 1938.

casionally have paid low prices for high yielding hogs, because the grade of the lot was low, and vice versa. But statistical investigation by means of simple and multiple correlation shows that grade had very little relation to price, except in the three cases where the hogs were definitely too low grade to qualify as Good to Choice. In these three cases the buyers took discounts up to 50 cents per 100 pounds, but in the other 57 cases differences in grade within the broad Good to Choice grade showed practically no relation to the price.

We may summarize, therefore, in these words: The buyers paid very little attention to yield; their prices were too "flat," too nearly average, and the correlation between price premiums or discounts and yields was only +0.34. They also practically ignored grade, except for the few lots of hogs that were definitely too poor to grade Good to Choice.

ACCURACY OF ESTIMATES OF YIELDS

Shortly after the research work for the preceding section was completed, the price quotation system at the plant where it was conducted was changed somewhat. The buyers conducted a test of their own of the accuracy of the live weight buying system, similar to the one reported in the preceding section, in order to measure the effect of this change in their pricing system. The test covered 19 lots of hogs.

The results were so similar to the results of the authors' test that it is unnecessary to report them in detail. One item was investigated in this test that was not included in the authors', however, and it yielded interesting results. The buyers recorded their estimate of the yield of each lot when it was purchased and compared this estimate with the actual yield determined when the carcasses were taken out of the cooler to be cut.

The buyer's estimate of the yields and the actual yields are plotted in fig. 7. The correlation is rather low, +0.56. Practically all of the correlation results from the one lot of heavy hogs weighing 374 pounds (which the buyers estimated to have a high yield and which bore out their expectations). This lot is represented by the dot in the upper right hand corner of the chart. But for this one lot, the correlation would have been practically zero.

These results confirm the general belief that while it is relatively easy for buyers to detect excessive "fill," it is difficult for them to detect differences in the yields of hogs that are not excessively filled, even though those differences are considerable.

COMPARISON OF PRICES PAID AND ACTUAL CUT-OUT VALUES

A second test of the accuracy of the prices paid for hogs was then made. In this test the prices paid for different lots of hogs were compared with the actual cut-out values of the different lots

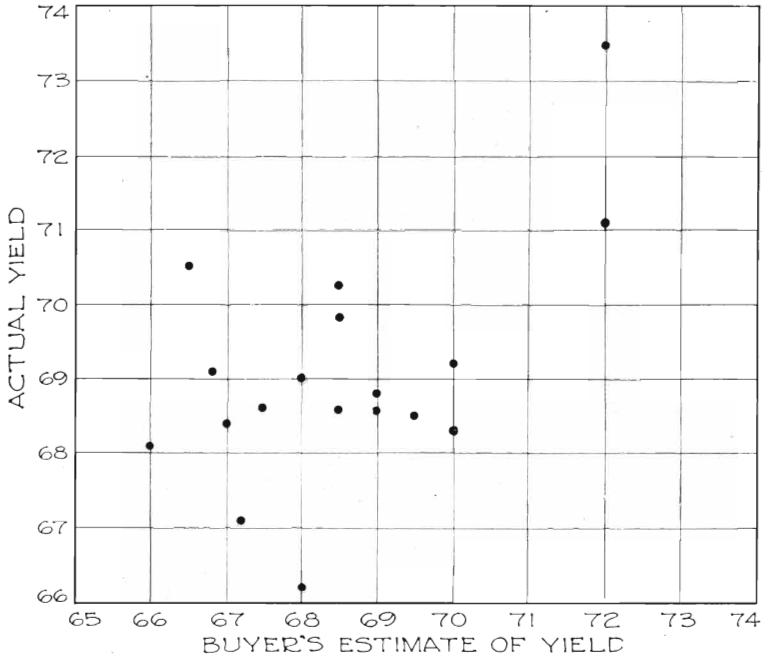

Fig. 7. Relation between actual yields and buyers' estimates of yields.

Instead of making complete cut-out value tests (which involved stopping the cutting gang for complete cleaning up of all scraps, etc., before and after each test) the authors based their tests on the five primal cuts—hams, shoulders, loins, bellies, fat back or back fat for lard. This reduced the expense of conducting the test by removing the need for interrupting the cutting gang.[11]

[11] This method does not give as accurate results as complete cut-out value tests. The primal cuts constitute only about 70 percent of the weight of the carcass, and the correlation between the total value of the primal cuts and the total value of the entire carcass is not perfect. But the remaining 30 percent of the carcass is made up of such items as leaf lard, jowls, feet, neck bones, kidneys, etc., most of which are low in value and relatively constant in percentage of the weight of the carcass. Accordingly, while the correlation between primal cut and total carcass values is not perfect, it is very high. In the case of the 6 sweepstakes lots of 10 hogs each that are cut up and valued each year at the International Livestock Exposition at Chicago, the correlation coefficients were as shown below:

Year	Correlation Coefficient
1933	0.92
1934	0.70
1935	0.99
1936	---*
1937	0.87
1938	0.75

* Detailed data missing.

These high coefficients mean that the results based upon the five primal cuts are similar, but not identical with, the results based upon total carcass values. The results here are preliminary or tentative, indicating rather closely the results to be expected from complete carcass value tests, but subject to some revision when such tests are made.

Accordingly, a number of cut-out value tests were conducted using the five primal cuts. The authors went into the cooler and put tags on all of the major cuts in the carcasses in the test lots before they were sent to the cutting floor. After the carcasses reached the cutting floor, the authors stood by the end of the cutting table and caught the tagged cuts just before they went down the chutes, put them on trucks, weighed and graded them and returned them to the chutes.

The cut-out value of each lot was then computed by multiplying the weights of the different kinds of cuts by the appropriate prices. The test covered a period of 8 days, from March 22 to 29. In order to make the results strictly comparable, a uniform set of wholesale cut prices was used throughout, taken from the National Provisioner for the week ending March 27. The prices paid for hogs changed during the 8 days; but for the last 3 days they remained steady, so the prices for the earlier days were shifted up or down as much as the market for that day was lower or higher than during the 3 days of steady prices.

In all, 13 lots of hogs ranging from 9 to 15 hogs each were tested. A larger number would have been desirable, but even though this method eliminated the need of interrupting the cutting gang, a considerable amount of extra labor was still required. Two members of the cutting floor force assisted. About 1,000 pounds of cuts had to be weighed by hand for each lot and recorded. This meant that the number of lots had to be kept reasonably small, but the collaboration of the cutting floor men ensured that the cuts were weighed, graded, etc. strictly in accordance with packing house practice.[12]

The results obtained by this procedure are shown in table 4. The cut-out values run lower than the prices paid, because they do not include all of the carcass nor any of the by-products. In column 11, therefore, the average difference between the prices paid and the cut-out values is added to the cut-out values to make them directly comparable as a whole. If the prices paid accurately reflected the cut-out values, the two series would then be identical. If not, the prices would be higher than the values in some cases and lower in others.

Figure 8a, based on table 4, shows the extent to which the prices paid for different lots exceeded or fell short of the cut-out values of those lots. It shows that in 5 out of 13 cases, the buyer hit within 10 cents of the mark. That was pretty good shooting. In four of the other eight cases, however, he missed the mark by amounts ranging from 30 to 50 cents per 100 pounds live weight. He hit

[12] For instance, the back fat was handled as fat backs or rejected for that purpose and thrown down to lard, the hams were skinned or not skinned, etc., in conformity with their regular practice.

TABLE 4. DIFFERENCES BETWEEN PRICES PAID AND CUT-OUT VALUES PER 100 POUNDS LIVE WEIGHT.

	1	2	3	4	5	6	7	8	9	10	11
Date purchased 1937	Tattoo number	Total live weight	Average live weight	Total carcass weight	Carcass yield (4)/(2)	Total wt. of five primal cuts	(6)/(4)	Price paid per 100 lbs. live wt.	Cut-out value per 100 lbs. live wt.	Difference between price paid and cut-out value	(10)—1.90 the average of (10)
March 22	50	2195	183	1384	63.1	908.50	65.6	9.35[1]	7.26	—2.09	—.19
" "	51	2285	254	1568	68.6	1097.50	70.0	10.00	8.02	—1.98	—.08
" "	52	2280	175	1565	68.6	1074.00	68.6	9.45	8.05	—1.40	+.50
" "	53	2870	221	1987	69.2	1344.50	67.7	10.05	7.80	—2.25	—.35
March 23	45	4065	271	2736	67.3	1908.25	69.7	10.05	7.77	—2.28	—.38
" "	47	3035	217	2052	67.6	1463.00	71.3	9.95	8.01	—1.94	—.04
March 25	05	3460	266	2396	69.2	1699.50	70.9	10.00	8.08	—1.92	—.02
" "	16	2065	172	1342	65.0	935.00	69.7	9.45	7.86	—1.59	+.31
March 26	27	2085	208	1384	66.4	967.25	69.9	9.75	8.02	—1.73	+.17
" "	28	2825	202	1963	69.5	1328.75	67.7	10.05	8.22	—1.83	+.07
March 27	35	2405	240	1646	68.4	1175.00	71.4	9.95	8.20	—1.75	+.15
March 29	36	1710	190	1089	63.7	753.00	69.1	9.50[2]	7.68	—1.82	+.08
" "	39	2530	211	1710	67.6	1187.50	69.4	10.05	7.96	—2.09	—.19

[1] The buyer discounted this lot 50 cents for low grade.

[2] The buyer discounted this lot 35 cents for low grade.

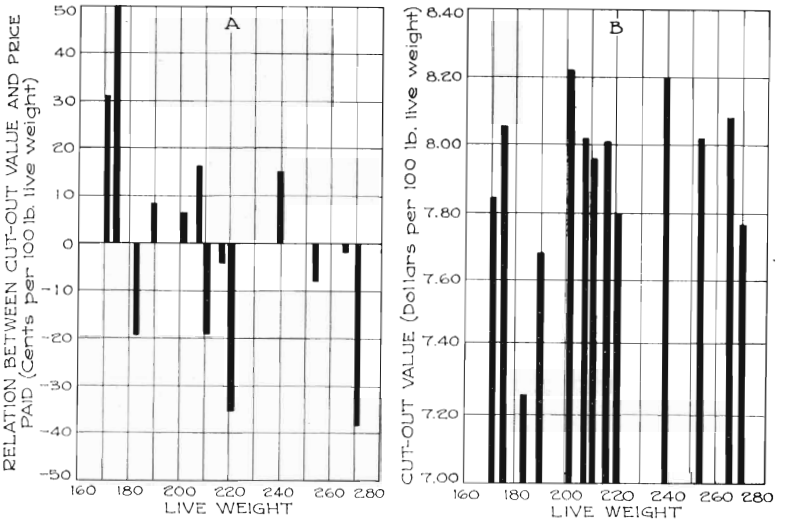

Fig. 8. Relation between cut-out value and price paid and live weight of hogs.

farthest above and next to lowest below on the same day. The average miss, or error, was 19 cents.

Figure 8a shows some correlation between weight and the direction of the errors. At that time hogs from 220 to 290 pounds live weight were covered in one quotation. Perhaps the heavier hogs within that broad weight range were worth less than the lighter hogs and should have been quoted separately at a lower price. Some evidence of this is shown in fig. 8b, where the cut-out value data are plotted as such, not as so much above or below the prices actually paid. There is some tendency for the values of the hogs weighing between 200 and 240 pounds to be higher than the values of the hogs weighing less than 200 pounds and more than 240 pounds, but it may be due merely to accidents of sampling.

This chart also shows that the two lots that were discounted sharply for their low grade had the lowest values of all. The 183-pound lot that was discounted 50 cents per 100 pounds should in fact have been discounted about $1 per 100 pounds (by comparison with the non-discount lots beside it). The buyer apparently detected the hogs that were below Good to Choice grade pretty well. What he was not able to do very accurately was to detect the differences in the values of the Good to Choice hogs.

These findings are not conclusive in themselves. The sample is small, and the cut-out values were not complete cut-out values (being based, as explained, only on the five primal cuts). The results are strikingly similar, however, to those of two similar experiments

TABLE 5. DIFFERENCE BETWEEN PRICE PAID AND CUT-OUT VALUE.

Number of hogs in lot	Excess of actual price paid per 100 lbs. live weight over cut-out value
6	63
7	23
15	14
7	8
12	— 5
1	— 6
4	— 8
11	—10
7	—33
1	—40
2	—44
7	—46
6	—53

conducted by a large Middle Western packer a few years earlier. A test was run at the plant on a lot of 86 hogs, bought from a number of individual producers. The hogs were carefully graded by the packer buyer, unusual care perhaps being exercised, as he knew a yield test would be run on each hog.

Cutting tests showed a variation in these hogs from the poorest to the best of 14 percent. The same price was paid for all. That meant that too much money was paid for the poor hogs and too little for the good ones.

The results are shown in table 5.

Then, quoting the manager of the plant directly:

"Out of these 86 hogs that all graded alike alive at the yards, the difference in yield between the best lot and the poorest lot was 9.35 percent. The difference between the best individual hog and the poorest individual hog was 14 percent.

"As I say, this in spite of the fact that the very competent buyer who was doing this grading knew that this was a test lot, and was being unusually careful and taking an unusual amount of time in an effort to make his grading accurate.

"Certainly, any competent hog buyer could guess weights more accurately than, in this case, a good man was able to guess yield."[13]

The second experiment was more extensive. In this case, 55 lots of hogs were purchased on the cut-out value basis. The arrangement was this: The packer would follow the carcasses through to the cutting table and pay the farmer according to the wholesale meat prices at Chicago reported and published weekly by the National Provisioner, minus a processing charge of 52 cents per 100 pounds. Detailed records were kept as to the number and quality of the hogs, and the prices that would have been paid if the hogs had been purchased on the ordinary buying basis. The results of the experiment are shown in table 6.

[13] The National Provisioner, Dec. 29, 1928. p. 23.

The data in this table are shown in the form of a frequency distribution in fig. 9. The broken vertical line in this chart represents the prices per 100 pounds that would have been paid if the hogs had been purchased in the ordinary way. The data that are plotted in the chart are the differences between these prices and the actual cut-out values.

One feature of these data needs to be borne in mind. In the first

TABLE 6. PRICES PER 100 LBS. ON THE LIVE WEIGHT BUYING BASIS COMPARED WITH ACTUAL CUT-OUT VALUES.

Date	No.	No. of hogs	Grade	Live weight	Yield	Cut-out value paid	Live wt. market value	Difference
4/5/33	1	8	Med.	1,795	67.1	3.49	3.40	.09
4/5/33	2	40	Med.	8,101	69.0	3.61	3.60	.01
		3	H.B.	820	71.3	3.53	3.50	.03
4/6/33	3	12	Med.	2,545	66.9	3.49	3.45	.04
4/8/33	4	12	Med.	2,575	68.5	3.54	3.54	.09
4/7/33	5	22	Med.	4,940	69.1	3.46	3.45	.01
		3	H.B.	860	71.4	3.43	3.35	.08
4/8/33	6	16	Med.	3,545	68.0	3.45	3.45	.00
		4	H.B.	1,005	70.0	3.41	3.35	.06
4/10/33	7	9	Med.	1,688	67.0	3.48	3.35	.13
4/11/33	8	11	Med.	2,075	67.9	3.52	3.35	.17
4/26/33	16	17	Med.	3,070	68.8	3.69	3.55	.14
		2	H.B.	550	71.2	3.70	3.45	.25
		1	PHB.	310	70.9	3.55	3.55	.20
		2	H.P.	905	69.2	3.19	2.95	.24
5/1/33	19	9	Med.	1,840	68.7	3.60	3.45	.15
		1	PHB.	320	70.0	3.36	3.25	.11
		4	H.P.	2,075	71.8	2.99	2.90	.09
5/1/33	20	20	Med.	4,293	68.7	3.61	3.45	.16
		8	H.B.	2,105	69.2	3.46	3.35	.11
		1	PHB.	357	69.5	3.14	3.15	—.01
		1	H.P.	475	67.6	2.78	2.90	—.12
5/4/33	21	17	Med.	3,745	70.8	3.71	3.50	.21
5/4/33	22	15	Med.	3,345	69.9	3.64	3.50	.14
4/15/33	9	8	Med.	1,555	68.8	3.60	3.35	.25
4/15/33	10	10	Med.	2,010	64.6	3.33	3.45	—.12
4/15/33	11	12	Med.	2,744	67.2	3.38	3.45	.07
		5	H.B.	1,296	68.5	3.32	3.35	—.03
		1	H.P.	550	67.2	3.01	2.85	.16
		1	Stag	525	65.4	2.25	2.25	.00
4/19/33	12	2	H.B.	544	71.5	3.50	3.15	.35
		1	PHB.	316	72.1	3.36	3.05	.31
4/24/33	13	1	Med.	225	63.1	3.29	3.55	—.26
		3	H.B.	780	68.1	3.47	3.45	.02
		3	P.H.	920	69.0	3.12	3.35	—.23
4/25/33	14	8	Med.	1,802	68.3	3.67	3.55	.12
		5	H.B.	1,327	68.2	3.62	3.45	.17
		1	PHB.	296	70.6	3.64	3.35	.29
4/25/33	15	14	Med.	2,980	65.7	3.63	3.55	.08
		1	H.B.	285	69.1	3.56	3.45	.11
4/29/33	17	2	Med.	480	66.5	3.38	3.45	—.07
		11	H.B.	2,930	70.0	3.52	3.35	.17
		2	PHB.	620	70.1	3.32	3.25	.07
4/29/33	18	4	H.P.	2,250	73.7	2.99	2.90	.09
5/10/33	23	5	Med.	950	67.1	3.79	3.75	.04
		1	PHB.	365	69.6	3.43	3.45	—.02
5/11/33	24	4	L.L.	595	66.4	3.44	3.60	—.16
		14	Med.	2,595	67.4	3.86	3.80	.06
5/12/33	25	10	Med.	2,266	68.9	4.22	4.15	.07
		3	H.B.	794	69.5	3.99	4.05	—.06
5/16/33	26	7	Med.	1,250	65.3	4.38	3.55	—.17
6/1/33	28	17	Med.	3,420	67.7	4.52	4.50	.02
		1	PHB.	505	72.9	4.47	4.40	.07
6/5/33	29	21	Med.	5,180	69.0	4.45	4.40	.05
6/8/33	30	9	Med.	1,955	68.7	4.22	4.25	—.03

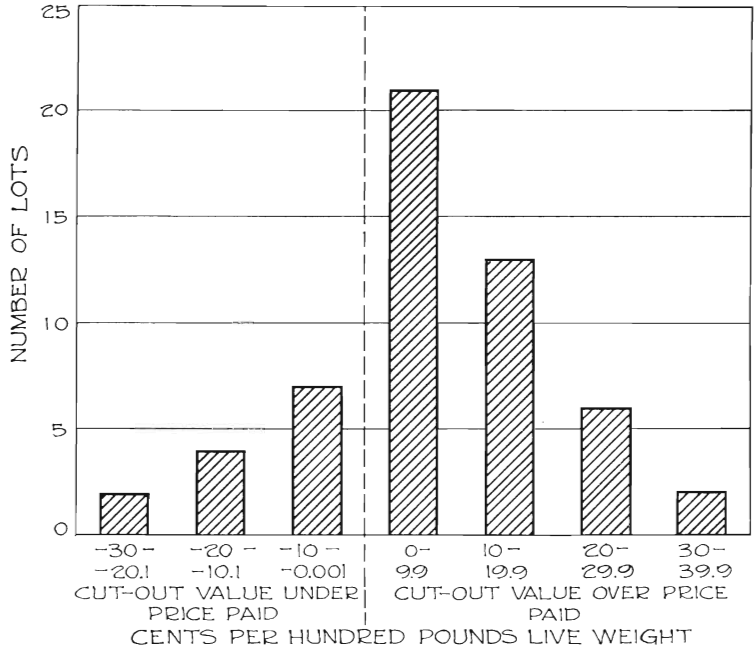

Fig. 9. Frequency distribution of differences between cut-out values and prices paid for 55 lots of hogs.

place, the packer's buyers made a conscious effort to buy high quality hogs for this experiment. If they had bought all kinds—good, bad and indifferent—the cut-out value of the poor quality hogs in most cases would have been less than their values based on ordinary buying methods; the farmers who owned those hogs would therefore have felt that they had been robbed. In order to reduce antagonism to the new method as much as possible, therefore, the buyers purchased only medium or high quality hogs, rather than all hogs just as they came. This is one reason why the bulk of the cases in fig. 9 fall to the right of the vertical base line.

The average difference between the actual carcass values and the prices that would have been paid live weight was 12 cents. This is less than the average difference found in the authors' test, partly because hogs were selling at only $3.54 per 100 pounds live weight when the packer made his test, while they were nearly $10 when the authors' was made. The coefficient of variation in his test was considerably larger than in the authors' test; it was 2.4, as compared with 1.5.

These tests of Experiment Station hogs and regular commercial hogs under packing plant conditions are further corroborated

by a study of the complete cut-out value tests of the six sweepstakes lots of hogs each year at the International Livestock Exposition. These cut-out value tests are made in full detail in one of the larger Chicago plants; they are as complete and accurate as it is possible to make them. They are shown compared with the prices actually paid for the hogs in table 7.

These hogs of course were all top grade, as is shown by their prize winning status. The carcass placings of these sweepstakes lots usually differ materially from their placings on foot, because, the judges say, the lots are all so good that the difference between them are very minor. But their cut-out values actually differ significantly, as table 7 shows. The average difference between prices and cut-out values is 11 cents. This is less than the average difference found for commercial hogs (19 cents), probably because of the greater uniformity of the show lots.

WHY IS THE LIVE WEIGHT BASIS INACCURATE?

The preceding sections have shown that the prices paid for different lots of hogs do not closely represent their actual cut-out values. Why is this? Is it physically impossible for buyers to price hogs on the hoof more accurately than they do? Or is the trouble rather with hog producers—that *they* cannot appraise their hogs accurately?

Perhaps the trouble lies entirely with the buyers, or rather with the basis on which they buy hogs. It may be that buyers buy hogs on the hoof as accurately as possible. If that is the case, then the reason for the inaccuracy of the buying is the fundamental inability of even the keenest buyers to look through a hog and see how much and how good a carcass there is inside.

It is more likely, however, that a substantial part of the trouble lies with the farmers themselves. A man who has raised a crop of hogs is likely to grade them higher than a buyer. If Farmer Brown comparing notes with Farmer Jones across the fence finds that he got 40 cents per 100 pounds less for his hogs than Jones did, he is more likely to conclude that the buyer "gyped" him out of 40 cents per 100 pounds than he is to agree that his hogs were actually worth that much less than his neighbor's. In that case he will either quit selling hogs to that packer altogether and take them to a buyer who does not pay as large premiums and discounts for high and low-grade hogs; or else if he goes back to the same buyer with his next load, he will refuse to leave them at the plant if the buyer again attempts to take a discount.

Buyers have no difficulty paying different prices for different *weights,* because the weight is objectively determined on scales, and farmers accept the verdict of the scales as to weight where they may not accept the verdict of the buyer as to grade. But they do have difficulty in paying different prices for different *grades,* be-

TABLE 7. PURCHASE PRICES AND CUT-OUT VALUES OF SIX SWEEPSTAKES LOTS AT THE INTERNATIONAL LIVESTOCK EXPOSITION ANNUALLY SINCE 1933. TEN HOGS IN EACH LOT.

	1	2	3	4	5	6	7
Rank of lot on foot	Live wt.	Carcass wt.	Yield	Purchase price per live cwt.	Cut-out value per live cwt.	Difference between 4 and 5 (cents per 100 lbs.)	Items in 6 minus av. of 6 (cents per 100 lbs.)
				1933			
1	2115	1494	70.64	$4.20	$4.83	63	0
2	2125	1483	69.78	4.20	4.83	63	0
3	**2120**	**1518**	**71.60**	4.20	4.89	69	+6
4	2100	1502	71.52	4.20	4.89	69	+6
5	1975	1431	72.46	4.20	4.91	71	+8
6	2200	1512	68.73	4.20	4.65	45	—18
				1934			
1	2135	1613	76.50	$9.16[1]	$9.01		—15
2	2050	1564	76.29	9.16	9.03		**—13**
3	2120	1620	76.41	9.16	9.35		+19
4	1975	1482	75.04	9.16	8.98		—18
5	1970	1489	75.58	9.16	9.29		+13
6	2050	1577	76.88	9.16	9.29		+13
				1935			
1	2049	1484	72.43	$13.60[1]	$13.48		—12
2	1990	1382	69.45	13.60	13.64		+ 4
3	2121	1511	71.54	13.60	13.66		+ 6
4	2093	1491	71.24	13.60	13.61		+ 1
5	2105	1541	73.21	13.60	13.79		+19
6	2136	1481	69.34	13.60	13.44		—16
				1936			
1	2260	1748	77.35	$10.50	$11.22	72	+ 7
2	2260	1714	75.84	10.50	10.94	44	—21
3	2270	1799	79.25	10.50	11.31	81	+16
4	1810	1363	75.30	10.25	10.74	49	—16
5	2310	1801	77.96	10.50	11.30	80	+15
6	2130	1640	76.96	10.50	11.14	64	—01
				1937			
1	2270	1693	72.73	$8.50	$8.84	34	—18
2	2250	1598	71.02	8.50	8.57	7	— 9
3	2220	1600	72.07	8.50	8.72	22	— 6
4	2320	1611	69.44	8.50	8.45	—5	—21
5	2170	1516	69.86	8.50	8.75	25	— 9
6	2330	1653	70.94	8.50	8.62	12	— 4

TABLE 7—(Continued)

			1938				
1	2475	1942	78.46	$7.95	$8.03		+ 8
2	2445	1912	78.20	7.95	8.00		+ 5
3	2510	1923	76.43	7.95	7.84		—11
4	2063	1619	78.48	7.95	8.02		+ 7
5	2563	1980	77.25	7.95	7.85		—10
6	2300	1834	79.74	7.95	7.96		+ 1

[1] The lots in all cases were bought at a uniform price—the top of the market for the day. The prices paid in 1934, 1935 and 1938 were not recorded on the data sheets, so the average of the cut-out values was used instead. This gives the same result as the constant prices used in other years.

cause the grade is not determined objectively. It is determined largely by judgment, and the farmer's judgment is very likely to be different from the buyer's. This is more the case since the farmer knows that the buyer is out to get hogs as cheaply as he can (just as the farmer is out to sell hogs as high as he can); the farmer is likely to regard any discounts for low grade hogs as mere camouflage for getting hogs cheaply.

EFFECT OF INACCURACY

The evidence in the preceding sections indicates that the live-weight system for selling hogs is not highly accurate. Well, what of it? Packers pay out about the same amount of money for a day's run of hogs under the live weight system as they would under the carcass weight system. Over a day's run, or at least over a week's run, the inaccuracies average out. So what is the harm?

Consideration of this question shows that the harm is two-fold. Under the live weight system, differences in yield are considerable but difficult to detect. Accordingly, packers pay too nearly a "flat price" within each weight class. Farmers naturally "fill" their hogs well before bringing them to market; they know that within reasonable limits they can thereby sell corn worth perhaps 55 cents per bushel, or about $1 per 100 pounds, for seven or eight times as much—$7 or $8 per 100 pounds—as hogs. Any excess water they can induce their hogs to drink adds still more weight. All of this is pure waste. It does not fool the packer. He simply lowers his price enough to offset the fill. The trouble is that he lowers it for those who do not fill their hogs as well as those who do.

The second disadvantage of the live weight system is that it provides only a small and uncertain incentive for producers to produce high-grade hogs. If a more accurate basis of sale could be worked out, each hog producer would get more nearly what his particular hogs were worth. The producer of high-yielding and high-grade hogs would get more than under the present live weight system, and the producer of low-yielding and low-grade hogs would get less. Under the stimulus of this incentive for raising high-

yielding and high-grade hogs, with the passage of time hog producers would bring in hogs of higher average grade and yield than under the present system. A year's run of these higher grade hogs would be worth more to packers and would enable them to pay more money to hog producers.

The situation now in the hog industry is similar to, although less extreme than, the situation existing in the butter industry a generation ago and in the egg industry still in many places today. The established practice used to be for butter and eggs to be taken in, in trade, by the local storekeeper, with no premium for quality. As a result, butter and eggs were very inferior products. It was not until butter was inspected, eggs were candled and premiums were paid for quality products that quality improved. What is needed is some system by which hogs can be "candled."

PRACTICABILITY OF CARCASS SELLING

The desirability of adopting a more accurate basis of sale for hogs has been indicated in the preceding section. Desirability, however, is only one thing; many things that are desirable are not practicable. The present section, therefore, considers the practicability (or otherwise) of carcass selling in the United States.

Two kinds of difficulties stand in the way of the adoption of carcass selling. The one kind is physical. These physical difficulties are those of identification of carcasses as they go through the plant, of accurate weighing and grading, of speedy settlement and of the handling of condemnations. The other kind of difficulty is what might be called economic, the nature of which will be taken up in detail later.

The physical difficulties are the ones that rise to mind first. They will now be considered in order.

PHYSICAL PROBLEMS

IDENTIFICATION

When hogs are paid for on the basis of their carcass weight and grade, how can the farmer be sure that the identity of his hogs is not lost before they are made into carcasses?

Hog farmers in Denmark have solved this problem by clipping metal ear tags into the ears of their hogs. Then when the hogs are sold, the packer records the numbers stamped in the ear tags in a book beside the owner's name. The weights and grades of the carcasses are then recorded beside the ear tag numbers.

The Canadians at first experimented with the use of ear tags, but they had some difficulty with them. It is a good deal of trouble to put ear tags in an American hog's ear in the first place; and in the second place, when the hogs go through the dehairing machine (the power scrapers) used in the packing plants, a number of tags get torn out.

After some experimentation, therefore, the Canadians turned to a different method of identification. They tattooed their live hogs on the shoulder at the time of purchase. Tattoo marks are easier to apply than ear tags, and they cannot be torn off. An efficient tattooing instrument, with a rotating head permitting speedy operation, and a good tattooing ink that will not run or fade out have been developed. The senior author has stood beside the carcass rail in Canadian packing plants and watched hundreds of carcasses roll by; the tattoo marks on the carcasses stood out unmistakably. Apparently, with the adoption of the tattooing system the problem of identification has been solved.

ACCURATE AND IMPARTIAL WEIGHING

When hogs are sold by live weight, they are weighed in the presence of the seller, on scales that are government-tested for accuracy. When hogs are sold by carcass weight, the seller is likely not to be on hand when the carcasses are weighed. What guarantee does he have that the weighing will be properly done?

The obvious solution to this difficulty is to have the weighing of the carcasses done by a disinterested third party, such as a government official. This solution has been adopted in Denmark and Canada and would seem to be the natural solution in the United States.

This impartial and accurate weighing of carcasses is generally done automatically by electricity. The government weigher merely checks and supervises the accuracy of the machine. As the carcasses roll by along the carcass rail, they pause for an instant on the weighing beam of the scales, and their weight (minus the weight of the gambrel and trolley) is stamped on a ticket by the machine. A clerk then writes the tattoo number on the ticket and hangs it on the carcass as it leaves the scale. This solves the weighing problem in a very satisfactory manner. Scales of this kind are available now which handle carcasses up to 600 or 700 per hour.

ACCURATE AND IMPARTIAL GRADING

When hogs are sold on the live weight basis, the buyer grades them at the time of sale. If the seller believes that this grading is unfair, he is free to take his hogs back (or, if the buyer has driven out to the farm and graded them in the feed lot, he can keep them in the lot). When hogs are sold by carcass weight and grade, however, the seller has no such recourse. If he does not like the grade placed on his carcasses, it is too late for him to take them back.

The obvious solution to this difficulty is to have the carcasses graded in the plant by a third party, presumably a government man, as in the case of the weighing. This also is the solution that has been adopted in other countries. In Canada, for instance, after the carcasses have rolled past the scale, the government grader takes

off the weight ticket that was hooked on to the carcass at the scales, glances at the weight, grades the carcass and writes the grade on the ticket. The three necessary items of information—the identification (the tattoo number), the carcass weight and the carcass grade—are then all on the ticket.

Carcasses, of course, can be graded more easily and quickly than live hogs. The carcasses are all open, the factors that make for grade are easily visible, and they all roll by the grader under uniform conditions of light and position. Carcass grading is not only easier, more impartial and quicker than live hog grading; it is also more accurate.

SPEEDY SETTLEMENT

When hogs are sold by live weight, the seller can deliver the hogs, see them weighed and go home with the buyer's check in his pocket. When they are sold by carcass weight, the seller must wait until the hogs are slaughtered and converted into carcasses.

In Denmark and Canada, the farmer does not have to wait long. If the Canadian farmer brings the hogs in in the morning, they are slaughtered just after lunch. The tickets are then taken to the main office, the accounts are made up and checks are issued in full settlement before the close of business that afternoon. The farmer either gets his check that afternoon or finds it in his mail next day.

In the United States, hogs that are brought in and sold on the live weight basis are paid for on delivery but are usually not slaughtered until the next day. If they were sold on the carcass basis they could not be paid for until they were slaughtered, the day after they were brought in. Some sellers might object to this delay in settlement. But it is doubtful if this objection would be serious. The farmer who consigns his stock to a terminal market now waits a day or two for his returns. The farmer who sells cream to his cooperative creamery waits 2 weeks. Probably farmers would become accustomed to waiting a day for their checks for hogs sold on the carcass basis. If not, a system that is used in parts of Canada could easily be adopted. A down payment of about 90 percent of the estimated value of the hogs is made to the farmer when he brings his hogs in. The rest is mailed to him a day or two later.

CONDEMNATIONS

Condemnations also constitute a problem. All livestock slaughtered in packing plants which do an interstate business is inspected by government veterinary inspectors immediately after slaughter. A small percentage of the carcasses (usually less than 1 percent) is found to be unfit for human food, in whole or in part, and condemned as unfit for human consumption.

"When livestock is sold on the hoof, the buyer is usually not able to detect the presence of bruises or diseases which may render

a part or all of a carcass unfit for human food. Accordingly, the animal is purchased at the same price as healthy stock. But the bruised or diseased portion or carcass is worth only a small fraction of the value of a healthy portion or carcass that is sold as fresh meat. The packer loses almost the full amount he paid for condemned meat. Since this loss is unforeseeable until after the animals are paid for and slaughtered, the packer recoups his losses by buying all livestock at a slightly lower price than he would pay if he had no condemnation losses to meet. He deducts from the price he pays for livestock a small insurance fee to cover his condemnation losses. In Canada, this deduction is uniformly 0.5 percent of the purchase price for hogs; it is shown, specifically as such, on every sales account sheet for livestock.

"When livestock is sold on the carcass basis, it is not paid for until after the carcass has been slaughtered and inspected. Accordingly, the packer is in a position to pay just what each carcass is worth; he could pay full price for healthy carcasses, and practically nothing for condemned carcasses. The farmer whose stock was condemned would suffer severe losses which at present he escapes. This would be equitable, but it would present a drastic break with past practice, and inflict the full penalty before the farmer would have time to clean up his herd. Yet unless the farmer is informed of condemnation, he is unaware of the need of improving his practices.

"In the light of these considerations, the Canadians have decided that, for the present, the traditional practice with respect to condemnations will be continued. That is, the packer will continue to deduct 0.5 percent of the price for all hogs, and pay full price for condemned or rejected carcasses, regardless of whether the hogs are purchased on the hoof or on the carcass basis. When the hogs are purchased on the carcass basis, however, the farmer will be informed if any of his carcasses were condemned or rejected. He will be paid full price for them, as under the traditional live-weight system, but he will know what steps to take, so that if in the future a change is made and the condemnation loss is placed squarely on the producer of condemmned carcasses, he will have had time to act upon the condemnation information previously given him."[14]

COST OF CARCASS SELLING

A final question is this: Even though the physical problems discussed above can be satisfactorily solved, does the bookkeeping and other work involved in carcass selling cost too much? In some of our large interior packing plants, hog slaughter normally amounts to 1 million head a year and occasionally runs up to 6,000 head a day. It is no small job to keep track of 6,000 carcasses a day

[14] Livestock marketing methods in Denmark, Great Britain and Canada. Iowa Agr. Exp. Sta. Bul. 353. p. 156-157. 1937.

and settle for them without confusion or mishap.

The cost of handling hogs on the carcass basis cannot be given in one specific figure. It depends upon the volume handled. Estimates of the additional cost of carcass selling under Canadian conditions, however, indicate roughly the order of magnitude that may be expected.

None of the large Canadian plants is carcass grading all of its kill, so the cost under conditions of full utilization cannot be given direct from actual operation. Two or three of the graders, however, made estimates of the cost for a full run of hogs, based upon their own experience with partial utilization. These estimates were then checked by packing plant operators and are given below.

The regular operating speed of a moving carcass rail in the ordinary operation of large Canadian packing houses, with or without carcass weighing and grading equipment, is about 500 hogs per hour. The rail is sometimes speeded up to 600 or more hogs per hour, but 500 is a good everyday operating speed.[15] In an 8-hour day, this would take care of 4,000 hogs.

If all the carcasses were being weighed and graded, the additional staff required to handle 4,000 hogs in an 8-hour day would be as follows:

(1) Two men with a tattooing instrument apiece out in the unloading pens of the plant, tattooing the hogs as they came in. Each of these men would need a helper to drive the hogs past him. The total number of men required for the tattooing, therefore, would be four.

(2) Two carcass graders in the plant. Hog carcasses can be graded more quickly and easily, as well as more accurately, than live hogs. A grader has no trouble grading carcasses at a rate of 550 per hour, but after 1 or 2 hours of continuous grading he needs a few minutes rest. Two graders could handle this situation very well by working alternately 1 hour each, the one resting, demonstrating grading in detail to farmers, etc., while the other was grading.

(3) The number of clerks in the main office, transferring the records from the tickets to the settlement sheets and getting out the checks, would depend in large measure upon the amount of mechanical calculating equipment provided. If they were equipped with ordinary adding machines, five clerks might be needed; if, however, combination calculating, recording and check-writing machines were provided, the number of clerks would be reduced to three or four. We will use five men (or, more likely, women) as the basis of our estimates.

The only members of this force who would be highly trained

[15] In the United States, the largest plants run at 550 to 600 hogs per hour, but the federal veterinary inspection service will not permit speeds in excess of 600 per hour.

would be the graders. Two graders at $10 per day would come to $20. The nine clerks and tattooers at $4 each per day would come to $36. The total wage bill per daily run of 4,000 hogs would, therefore, be $56. The cost of tickets and the depreciation on the weighing and other equipment would not be more than $20. The total cost, therefore, would be $76. On a run of 4,000 hogs, this would amount to 2 cents per hog, or about 1 cent per 100 pounds live weight.[16] On a run of hogs smaller than 4,000, of course, this cost per hog would rise, perhaps to as much as 3 cents per hog, or 1½ cents per 100 pounds live weight.

The cost in the United States should not be any higher than 1 cent per 100 pounds live weight. It might be lower, since the use of the carcass basis enables certain savings to be made which offset part of the costs. When hogs are sold on the hoof, a considerable amount of sorting is often necessary. A truck load of 20 hogs, for example, may be made up of 10 butcher hogs weighing 220 to 240 pounds, seven weighing from 200 to 220 and three weighing from 180 to 200 pounds. Different prices are ordinarily quoted for each of these weight classes. The hogs would have to be sorted into three lots and weighed in three separate drafts. If they were sold on the carcass basis, however, they would all be run in as one lot and "sorted" on the carcass rail by the grader without any physical sorting being required. This would reduce the *net* cost of handling hogs on the carcass basis.

The answer to an inquiry addressed to the manager of one of the largest Canadian packing plants on the subject of the costs of handling hogs on the carcass basis is illuminating.

"Due to two factors, it is rather difficult to give you accurate information (concerning costs).

1. At present it is optional with the seller to sell on:
   (a) Rail grade, or
   (b) Live grade.
   This makes it necessary for us to have a setup in yards and office to take care of both systems with a resulting loss in efficiency.
2. Our kills only run around 300,000 hogs per year.

However, our experiences, taking these factors into account, are sufficiently broad to state that:

On a basis of a kill of 1 million hogs per year all bought on a rail grade basis that:

---

[16] This estimate is regarded by Canadian authorities (graders and plant managers) as very liberal. A further check of the estimate is provided by the fact that the total Canadian hog grading budget for 1935 was only $100,000 for 2,805,825 hogs, about 3½ cents per hog. This amount covered all the costs, graders' salaries, overhead administrative expense, traveling expenses, etc., of conducting their live hog grading system and developing their carcass grading system as well (the latter involving some part-time extension work by the graders).

(a) Yard labor would be *reduced* from 20 to 25 percent.
(b) Clerical labor would be *increased* from one man to one and a half to two men. This would, of course, depend to quite an extent on the costing requirements of various plants.

However, by rail grading using the "tattoo" system of marketing it is not necessary to:

(a) Weigh hogs off truck,
(b) Grade hogs off truck or car,
(c) Pen hogs in separate lots.

Further, tattooing eliminates the danger of mixing lots in the shackling pen and the scalding vat.

Summarizing, we estimate that on the basis of 20,000 hogs per week, it would take the following staff.

	Alive	*Rail*
Yards	7 men	5 men
Office	1 man	2 men
Total	8 men	7 men"

The largest plant in Canada slaughters only about a third of a million head of hogs per year. Our largest plants, running up to a million head, would probably be able to handle a large part of the sorting of tickets and settling for the hogs by punch card machinery. This would also reduce costs.

EXPERIENCE WITH TATTOOING IN THE UNITED STATES

The question has occasionally been raised as to whether it is physically possible to tattoo and keep track of the large volume of hogs handled in one of our big packing plants. This question can be answered by actual experience. In 1930 the manager of one of the largest hog packing plants in the United States, located in South Dakota and handling 1 million head of hogs a year, was troubled by the fact that many of the hogs were tuberculous. A little more than half of the hogs came in from immediately surrounding territory by truck. In an attempt to trace back the origin of the tuberculous hogs and clean up the situation, he decided to tattoo every hog brought into the plant by truck and trace it through to the carcass and back to the producer. This was done for 5 years, until the tuberculous condition was improved and tattooing was no longer necessary. No particular difficulties were encountered, and the costs were lower than the estimates based on Canadian experience given above. A letter from the superintendent of the plant states, "Our costs per 100 hogs for tattooing based on present wage rates would figure close to 60 cents per 100 for tattooing and 15 cents per 100 for inspection and checking on the dressing floor. The combined cost would then be close to 75 cents per 100 hogs."

This would be less than 1 cent per hog. The writer then adds that if 100 percent perfect identification were required, the costs would be somewhat higher.

Concerning the physical arrangements, he goes on to say: "Our yard arrangement for tattooing was as follows: A chute 2 feet wide and 12 feet long is placed at the outlet of the weighing scale and as the hogs pass through this chute in single file, they are tattooed on the upper part of the shoulder. The tattoo letters are changed for each purchase of hogs and marked in a record book and on the hog scale tickets. The hogs are then checked for T. B. on the hog dressing chain and a report turned in to the office on the findings."

ECONOMIC PROBLEMS

The physical problems involved in selling carcasses are comparatively simple, and satisfactory methods for handling them have been worked out. They no longer constitute an obstacle to carcass selling. But some economic problems, of a more elusive character, still await solution before this method could be put into practice.

LIVE WEIGHT PRICES AND CARCASS PRICES PER 100 POUNDS

One of these economic problems is the determination of an equitable ratio between the price of hogs per 100 pounds live weight and the price of carcasses per 100 pounds carcass weight.

The carcass basis was put into effect in Canada gradually, first at one plant, then extended to another and so on. The packers simply offered to buy hogs on the carcass basis as well as on the live hog basis, so that two sets of price quotations were (and still are) used, side by side, the one for live hogs and the other for carcasses. We might do the same in the United States. If the weight of the carcass, on the average, equaled 70 percent of the weight of the live hog, then the price of the carcass should be 100/70 times as high as the live weight price. If hogs were selling for $10 per 100 pounds live weight, they should sell for $10x100/70, or $14.29, per 100 pounds carcass weight.

But things are not so simple as this. In actuality, heavy hogs dress out(or yield, in packer parlance) higher than light hogs. If packers quoted carcass prices for all weights of hogs that were 142.9 percent of live hog prices, farmers would soon figure the thing out and sell their heavy hogs (which would dress out higher than 70 percent) on the carcass basis, and their light hogs (which would dress out less than 70 percent) on the live weight basis. The ratio between live weight and carcass prices would have to be different for each weight range of hogs to correspond with the differences in actual yields.

The way in which average yields vary with weight is shown in

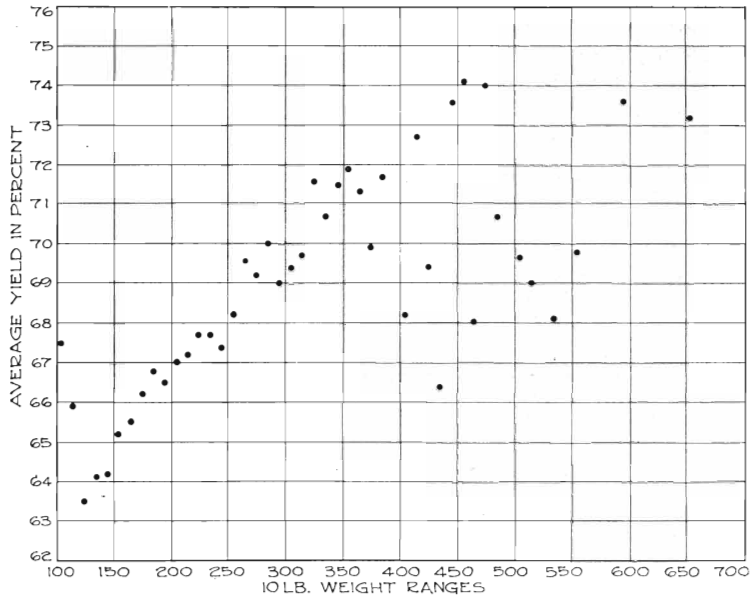

Fig. 10. Relation between average yields (by 10-pound weight ranges) and live weight.

fig. 10. This figure is based upon the data compiled in a study of 1,000 individual hogs in a large Middle Western packing plant a few years ago. The yields in this study rise about 0.7 percent for each 20-pound increase in weight. They are shown in the first yield column of table 8. The yields of individual hogs slaughtered at the college show a similar relation to weight. The yields of the 60 lots of hogs reported earlier in this bulletin showed an increase of slightly more than 1 percent for each 20-pound increase in weight. The sample is rather small, but the difference between these results and the individual hog results is considerable.

There is a general belief in the trade that yields increase about 1 percent for each 20-pound increase in weight, the increase being more than this in the light weights and less in the heavier weights. This belief is given some conformation in fig. 10. This relation was finally adopted as the basis from which the deviations of the yields of the 60 lots from the average yield for each weight class were computed in the earlier part of this study. It most nearly represented the average relation of the several different sets of yield and weight data. It is shown along with the average yields of the 1,000 individual hogs in table 8.

Tables of this sort would need to be worked out in conference with packers and given wide publicity, so that hog producers would

TABLE 8. AVERAGE YIELDS BY 20-POUND WEIGHT CLASSES.

	Based on 1000 individual hogs		Based on 60 lots of hogs	
	Yields	Differences between successive items	Yields	Differences between successive items
140-160	64.6		63.4	
160-180	65.6	1.0	64.7	1.3
180-200	66.4	0.8	65.9	1.2
200-220	67.1	0.7	67.0	1.1
220-240	67.8	0.7	68.1	1.0
240-260	68.4	0.6	69.0	0.9
260-280	69.0	0.6	69.8	0.8
280-300	69.5	0.5	70.4	0.6
300-320	69.9	0.4	70.8	0.4

be able to appraise live weight and carcass bids accurately. Otherwise, many hog producers, not undertsanding why the relation between live weight and carcass weight prices varied with weight, might think that packers were misusing the carcass system to their own price advantage.

Before carcass selling was put into operation, conferences among packers and others would need to be held, with the object of standardizing dressing styles so as to make carcass prices comparable between plants.

THE BASIS OF CARCASS GRADES

A second economic difficulty in the adoption of carcass selling is that no uniform clear-cut set of hog carcass grades is in general use in the trade. When hogs are sold by carcass weight and grade, the carcasses must be graded as well as weighed, and before carcasses can be graded an acceptable set of carcass grade specifications needs to be worked out.

The factors which determine the grade of a carcass are considered under three heads: (1) Conformation, (2) finish and (3) quality. These terms are defined as follows:[17]

(1) *Conformation.* "The term 'conformation' refers to the general build, form shape, and contour or outline of the carcass, side or cut. Conformation is determined by the skeleton, the thickness of lean meat and the thickness and distribution of fat. It involves plumpness and blockiness or stockiness on the one hand and ranginess, lankness and angularity on the other. These terms refer to the extreme limitations of conformation, between which are placed all the modifications and degrees of conformation that apply to the various grades . . ."

[17] "Market classes and grades of pork carcasses and fresh pork cuts" by W. C. Davis, B. F. McCarthy and J. A. Burgess. U. S. Dept. of Agr., Cir. 288, October, 1933, p. 7-8.

(2) *Finish.* "Finish in pork refers to the thickness, color, character and distribution of fat. The internal indications of high finish are generous quantities of firm white fat in the crotch, around the kidneys, over the ribs and along the breast bones. A high degree of finish adds much to the attractiveness of the carcass or cut, but its chief significance lies in the fact that there is evidence that up to a certain point intermuscular and intercellular fat is associated with palatability. Furthermore, finish without wastiness serves as an excellent index of the degree of quality in the meat. Thick or wrinkled skin, a lack of fat in the crotch, poorly covered kidneys and ribs, and general scarcity of fat along the breastbones are indications of poor finish."

(3) *Quality.* "Quality is a characteristic of the lean flesh and of the fat included therein. It pertains primarily to the thickness, firmness and strength of both the muscle fiber and the connective tissue. It also involves the quantity, consistency and character of juices or extractives that surround and permeate the muscle fiber and connective tissue. Color is not actually a factor of quality, but is an excellent indication of the quality of a given piece of meat."

OBJECTIVE CARCASS GRADE SPECIFICATIONS

The three factors given above are those that determine grade. The step required now is to outline a set of specifications for each grade, basing them on the three grade factors described above.

The more explicit the grade specifications are, the more accurate and uniform the grading will be. Wherever possible, it is better to lay down specifications in quantitative terms, in inches for example, than to use such words as "long," "short" or "very thick," "moderately thick," "thin," etc.

Early in their research work, therefore, the authors attempted to set up a system of objective carcass grade specifications. But where were they to begin? How long should a 150-pound No. 1 carcass be, or a 170-pound No. 1 carcass or No. 2 carcasses in these weight groups? How thick should the back fat be? They did not know.

In order to find out, the authors graded and weighed a random sample of 830 carcasses from the regular run of butcher hogs in a packing plant. The grades we used were No. 1, No. 2, No. 3 and No. 4. They correspond fairly closely with the live hog grades, Choice, Good, Medium and Common, in general use in the trade.[18]

The carcasses were then measured in an endeavor to discover a more specific definition for grades. The distribution of the carcasses, by weight and grade, is shown in table 9. The most numerous group in each weight and grade is shown in italics.

[18] The authors' grading of 100 carcasses was compared with the buyer's grades of the original hogs from which the carcasses were made. The grades were identical in 93 of the cases. They differed by one grade in the other seven cases.

TABLE 9. DISTRIBUTION OF CARCASSES BY WEIGHT AND GRADE.

Grade No.	Carcass weight in pounds							
	60—80	80—100	100—120	120—140	140—160	160—180	180—up	Totals
1	1	9	53	114	135	68	17	397
2	1	12	90	171	90	25	6	395
3	--	8	18	12	4	--	--	42
4	1	1	--	---	---	--	--	2

Average weight—136 pounds.

Three measurements were taken (1) The length of the carcass from the inside of the aitchbone to the anterior side of the first rib; (2) the thickness of the back fat at three points—the first rib, the last rib and the lumbar-sacral junction; (3) the depth of the carcass at two points—the flank and the seventh rib.

CARCASS LENGTH

The carcass lengths, by weights and grades of carcasses, are shown in the first three sections of fig. 11, one section for each grade. The average length for each 10-pound weight class is shown by the heavy line in each chart. The three different average

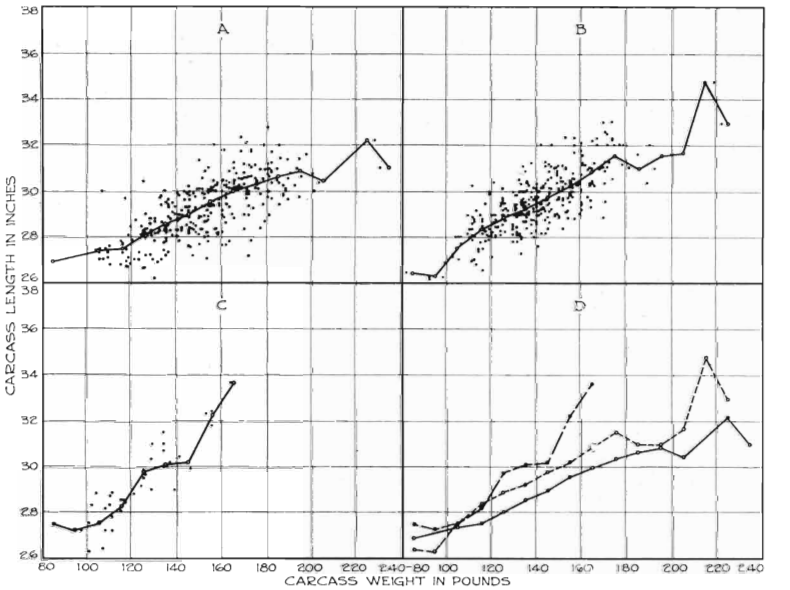

Fig. 11. Relation between carcass length and carcass weight.

lines from the first three sections of the chart are shown together in the fourth section.

The figures show that the variation in length is considerable. The items in each weight group cover a range of 4 or 5 inches. The average lengths for each 10-pound weight group, however, show a fairly steady increase from one weight group to the next, except for the lowest and highest weight where the numbers of items are too small to yield reasonably stable averages. Within the range of carcass weights from 110 to 200 pounds the length of the No. 1 and No. 2 carcasses increases approximately half an inch for every 10-pound increase in weight. The No. 2 carcasses average a little more than half an inch longer than the No. 1's. The reason for this, apparently, is that the No. 2 hogs are rangier built and thinner than the No. 1's; they get into the same weight class only by being longer. The No. 3 cacasses are still longer than the No. 2's. This extra length increases with increasing weight.

BACK FAT THICKNESS

A piece of back fat must be at least 1.5 inches thick before it can be made into a fat back. Accordingly, the chief consideration in back fat is the thickness at the thinnest point. Uniformity comes second to this (aside from softness).

Study of the back fat measurements shows that almost invariably the fat is thinner at the last rib than at either of the other two places measured (the first rib and the lumbar-sacral junction). In view of the importance of minimum measurements, therefore, attention is focused here upon the thinnest measurement, at the last rib. The back fat thicknesses at the last rib for the three grades of carcasses are shown in fig. 12. Two features of the data stand out clearly: (1) There is a considerable amount of scatter of the individual measurements about the average for each grade; (2) when the average measurements for each grade are plotted on the same chart (as in the final section of fig. 12) the averages for the higher grades run consistently higher than the averages for the lower grades.

It had been thought that the carcass depth measurements, either directly or as a ratio of one to the other, might reflect differences in the shape of the carcass—in the proportion of length to depth and in the proportion of fore-quarter to hind-quarter depth. However, with the exception of a slight tendency for the No. 3 grade carcasses to be deeper at the seventh rib than the No. 1 and No. 2 carcasses, no significant differences between the carcass depth measurements for the different grades were found.

The preceding group of charts shows that there is a considerable degree of scatter and overlapping in the measurements of carcasses of different weights and grades. This does not necessarily mean that the grading or measuring was inaccurate. It may result mostly from the fact that a carcass might have a No. 1 ham, a No. 2 belly

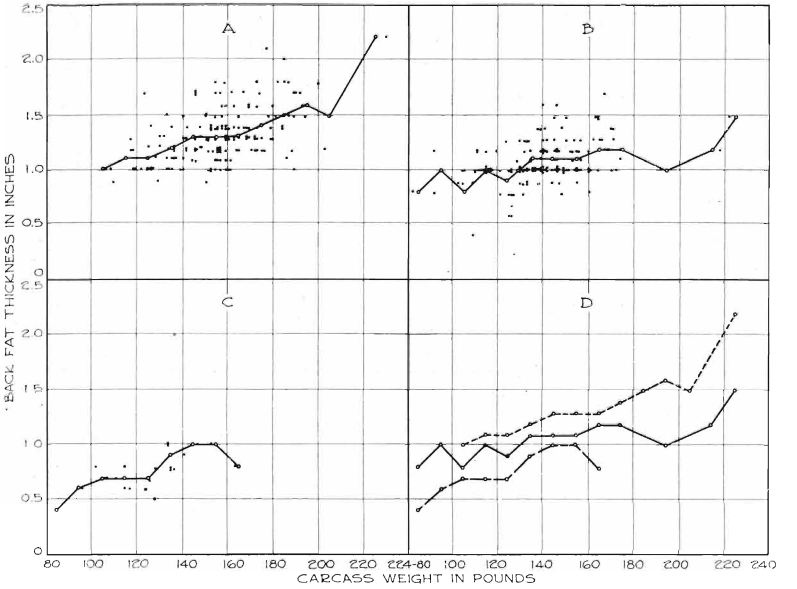

Fig. 12. Relation between back fat thickness and carcass weight.

and a No. 3 shoulder. The carcass as a whole would grade No. 2, but the measurements of the ham and shoulder would differ from the No. 2 measurements.

The charts show also that the *average* measurements by weight and grade constitute a reasonably consistent system. They agree closely with another study conducted at a different plant.[19] These average measurements might be used as a first step toward a system of objective carcass grade specifications.

An idea of the nature of such a set of objective grade specifications may be gained from an inspection of table 10. In this table the average measurements of the carcasses shown in the preceding charts are smoothed slightly and combined in tabular form.

It is highly desirable that some such system of objective carcass grade specifications be discussed, outlined, amended and finally agreed upon as standard for research and commercial use. Hog carcass grades are used extensively in everyday packing plant operations, and a uniform system of carcass grades has recently been set forth in a bulletin of the Bureau of Agricultural Economics at Washington; but none of these sets of grades is specific enough for extensive research purposes, and they are difficult to apply in such a way as to insure uniformity in commercial grading that might fol-

[19] Gleason, J. J. The adaptability of carcass measurements to the grading of hogs. Unpublished thesis. Library, Iowa State College, Ames, Iowa, 1938.

TABLE 10. AVERAGE HOG CARCASS MEASUREMENTS.

Carcass weight range in pounds	80-100 lbs.	100-120 lbs.	120-140 lbs.	140-160 lbs.	160-180 lbs.	180-up lbs.
Grade No. 1						
Carcass length in inches*	27	28	29	30	30.5	31
Back fat thickness in inches						
First rib	1	1.2	1.4	1.5	1.6	1.7
Last rib	1	1.2	1.3	1.4	1.5	1.6
Sacral-lumbar junction	1.2	1.6	1.8	2.0	2.0	2.0
Grade No. 2						
Carcass length in inches*	27.5	28.5	29.5	30.5	31	31.5
Back fat thickness in inches						
First rib	1	1.1	1.2	1.3	1.4	1.5
Last rib	1	1.1	1.1	1.1	1.2	1.2
Sacral-lumbar junction	1.2	1.5	1.7	1.8	1.9	2.0
Grade No. 3						
Carcass length in inches*	28	29	30	31.5		
Back fat thickness in inches						
First rib	0.8	0.9	1.0	1.0		
Last rib	0.7	0.8	0.9	1.0		
Sacral-lumbar junction	1.1	1.3	1.4	1.5		

* From the inside of the aitchbone to the anterior side of the first rib.

low. The commercial grades are not uniform from one packer's plant to another, nor are they necessarily uniform at one plant throughout the year or from one year to another.

Furthermore, the grades are largely qualitative. Even the uniform grades outlined by the Bureau of Agricultural Economics run in these qualitative terms. For example, "A No. 1 grade fat-type pork carcass has excellent conformation, finish and quality. The back is very broad, thick and plump; hams and shoulders are very thick, short and blocky." The specifications for No. 2 carcasses are a verbatim copy of this description, except that the "excellent" is changed to "fair," one of the "very's" is changed to "moderately," and the other is merely omitted.[20] There is scarcely any quantitative specification in the entire system. How broad is "very broad?" How thick is "very thick?" If two graders disagree as to this, how could they settle the argument?

[20] Davis, W C., McCarthy, B. F. and Burgess, J. A. Market classes and grades of pork carcasses and fresh pork cuts. U. S. Dept. Agr., Cir. 288, p. 9. 1933.

Perhaps the best—or rather, worst—example of indefinite specifications is to be found in the Chicago Board of Trade Rules and Regulations Relating to Provisions and Beef. Their specifications for Wiltshire sides, given on page 23 of the 1936 edition of their Rules and Regulations, start out: "Wiltshire Sides. Shall be made from nice smooth selected hogs."—followed by several other sentences of a similar kind. This is about the same as saying that a certain grade of coal should consist of nice, solid, selected lumps, without laying down any definite specifications as to heat content per pound, freedom from slate, etc.

The strictly qualitative nature of the present carcass and meat cut grades means that they are necessarily subjective in use. If two graders have been well-trained in the same part of the country, they would probably grade carcasses much alike; but if they have been trained or experienced in different parts of the country, or have different ideas for any other reason, they are likely to differ in their grading; and which of them is right? If coal, for example, were sold by the load, as hay used to be, a coal dealer might sell what he claimed was an average load. The buyer might object, saying that the load was too small. No one could say which of them was right. But the question could be settled quickly and accurately by running the load on scales or by measuring it up with a yard stick and comparing it with a standard load described in pounds or in cubic feet.

The difficulty of setting up objective, quantitative carcass grade specifications for hog carcasses is obvious to everyone who knows what a complicated piece of merchandise a hog carcass is. But measurements of the kind given in tables 1 and 2 could be used as an approach to a "yardstick," a system of specifications for grading hog carcasses.

The tables are obviously incomplete, for they leave out such things as plumpness of ham, thickness of belly, firmness of meat and quality of meat. They do, however, bring several very important grade factors within the field of objective measurement. The thickness of the belly pocket could quite easily be added to this list of measurements, making them considerably more complete.

The purpose of these carcass specifications would be to ensure uniformity in grading. It would provide objective standards to check or test the accuracy of a different grader's grading. A grader would not use a tape and take these measurements of each carcass in his regular grading. That would take too much time. He would use them merely in settling disputes and occasionally to keep his own grading "on the track." In other words, this set of specifications would not be a set of measurements to be taken of each carcass; it would be a set of calipers by which a grader would calibrate his grading. Carcass grading would still be done by eye,

but the accuracy of the eye would be checked by these objective specifications.

For comparison with our table, the specifications used for Canadian hog carcass grades are given in table 11. Two or three million hogs have been settled for on the basis of these carcass grades; the system of objective specifications is apparently quite practical under commercial conditions rather similar to those in the United States. There is one important difference, and that is that attention in Canada is focused on the export market, whereas in the United States the export market is comparatively unimportant. Whether this point is as important as it seems is discussed later.

It will be noticed that the carcass specifications in our table constitute one set or system. The Canadian specifications divide carcasses into two broad groups or classes, "Bacon Grades" and "Pork Grades." The suggestion has been made that the system in the United States should also provide for two classes, in our case, "Meat-

TABLE 11. STANDARDS FOR CARCASS GRADING OF HOGS. WEIGHT RANGES AND CARCASS MEASUREMENTS.

Bacon grades			
GRADE "A"	CLASS 1		
Weights	140-170 lbs.		
Minimum length	29"		
Max. fat shoulder	2"		
Max. fat loin	1½"		
GRADE "B"	CLASS 1	CLASS 2	CLASS 3
Weights	135-175 lbs.	125-134 lbs.	176-185 lbs.
Minimum length	28"	27"	30"
Max. fat shoulder	2¾"	2"	2¾"
Max. fat loin	2"	1½"	2¼"
Pork grades (No minimum length requirement)			
GRADE "C"	CLASS 1	CLASS 2	CLASS 3
Weight	135-175 lbs.	120-134 lbs.	176-185 lbs.
Max. fat shoulder	3"	2¼"	3¼"
Max. fat	2¼"	2"	2½"
GRADE "D"	CLASS 1	CLASS 2	CLASS 3
Weight	135-175 lbs.	120-134 lbs.	176-185 lbs.
GRADE "E"	Includes unfinished or oily; rejected or condemned; physical injury; stags and ridglings.		

Lights: weights 119 lbs. and under.
Heavies: weights 186 lbs. to 205 lbs.
Extra Heavies: weights 206 lbs. and over.

type" (bacon type) and "Fat-type" (lard type) carcasses.[21] Our preliminary carcass specification table is not thus divided. The desirability (or otherwise) of a "double-barreled" system of hog carcass grades needs investigating under actual commercial practice in the United States.

CAN CARCASS GRADES BE BUILT UP FROM WHOLESALE CUTS?

It may be that the problem of objective carcass grades should be approached from a different angle. Perhaps the grades should be based directly upon the weight and grade of the wholesale cuts in the carcass. Instead of making carcass grades similar to live grades, perhaps we should face the other way around and base grades on the cuts which the carcasses will make. The basic job then would be to define the cuts objectively; a No. 1 ham, from a 140 to 160-pound carcass, for instance, would be a certain number of inches long, with a certain thickness of fat and a certain total weight. The carcass grades would then run in terms of these cuts.

For example, if the back fat is more than 1.5 inches thick at the thinnest point and sufficiently firm, it can be pickled, made into a fat back and sold as such. If it is not thick and firm enough, it is thrown down into lard. The yield of lard from fat backs is between 75 and 80 percent.[22] A fat back gains some weight in the pickling, so the yield of lard compared with the selling weight of the fat back is nearer 75 than 80 percent.

Fat backs run from 7 pounds to as high as 19 pounds in the trade. A piece of back fat just thick enough to make a fat back would ordinarily weigh about 7 pounds. If it were just a trifle thinner, it would have to be thrown down into lard. With a yield of 75 percent, 7 pounds of back fat would make a little over 5 pounds of lard. These figures refer to one side. For the entire carcass the weights would be twice as great; 14 pounds of back fat would make 10.5 pounds of lard.

Fig. 13 shows that fat backs ordinarily sell at about the same price per pound as lard (although since the drouths of 1934 and 1936 they have been selling somewhat higher). As a very rough approximation we may use 10 cents a pound at the packing plant to represent the prices for both products. Back fat just over 1.5 inches thick, then, would be worth 14x10=$1.40 per hog; while if it were just under 1.5 inches thick, it would be made into lard, with a value of 10.5x10=$1.05. The difference between these two values is 35 cents. Thus a hog the back fat of which is more than 1.5 inches thick is worth 35 cents more than another hog identical in all respects except that his back fat is less than 1.5 inches thick.

[21] Davis, W. C., McCarthy, B. F. and Burgess, J. A. Market classes and grades of pork carcasses and fresh pork cuts. U. S. Dept. Agr., Cir. 288. 1933.

[22] Aldrich, Paul I., Pork packing. The National Provisioner, p. 195. Chicago. 1932.

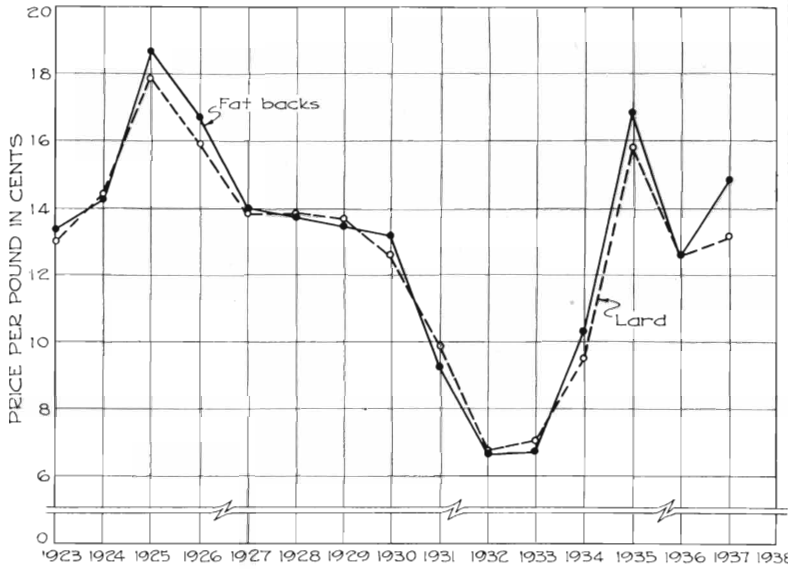

Fig. 13. Yearly average prices of fat backs and of lard 1923-1937.

HAMS

The effect of the grade of the ham on the cut-out value of the carcass is shown by the price spread per pound between No. 1 and No. 2 hams. Prices are quoted for several different weight ranges of hams.[23] The average butcher hog of about 220 pounds would have hams falling into the 14 to 16-pound weight class, so that weight was selected. But it was found that quotations for that weight were omitted during 1935 (following the drouth of 1934) so prices for 12 to 14-pound hams were also taken.

This amount of the spread per pound between No. 1 and No. 2 hams is shown for each year for the past 10 years in fig. 14. This chart shows that the annual average spread in price per pound between No. 1 and No. 2 hams has ranged between 2 cents in 1930 to 1 cent in 1933, and back up to 2 cents again in 1937. There is not much regular seasonal variation in these spreads, although irregular fluctuations from month to month are prominent, ranging from 0.4 cents in 1933 to 3.2 cents in 1934. The average difference over the whole period is 1.5 cents per pound.

Two 14 to 16-pound hams together would weigh on the average about 30 pounds. A carcass with No. 1 hams is, therefore, worth on the average 30 x 1.5 = 45 cents more than a carcass with No. 2 hams.

[23] They are published in "Livestock, Meats, and Wool Market Statistics" weekly mimeographed Booklet. B. A. E. Washington, D. C.

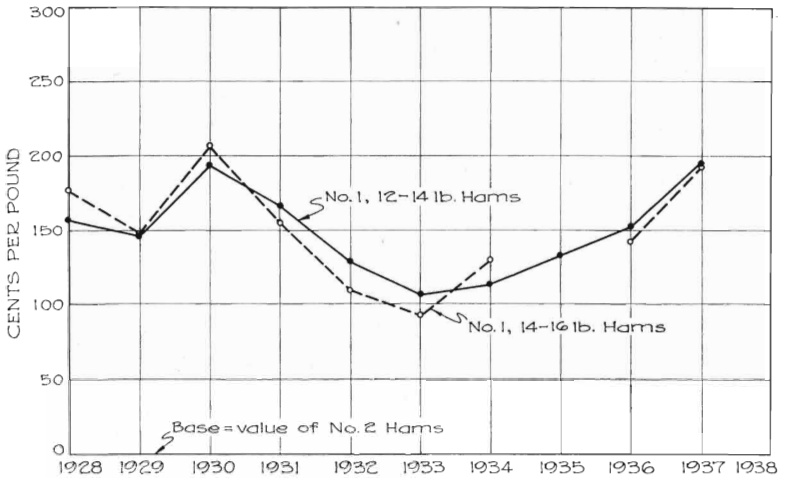

Fig. 14. Yearly average differences between the prices of No. 1 and No. 2 12 to 14-pound and 14 to 16-pound hams.

This sort of computation can be applied to the other wholesale cuts, where variations in weight are the chief consideration. The process becomes complicated, however. If loins are worth 20 cents a pound, one carcass with 2 pounds more loin than another carcass of equal weight is not worth 40 cents more than the other carcass; for if there are 2 pounds more loin there are two pounds less of some other cut or cuts, for example, the shoulder. The one carcass is worth only the difference between the values of loins and shoulders. Further study is called for here.

PRICE DIFFERENTIALS FOR DIFFERENT GRADES OF HOGS

Some indication has been given in the preceding section as to the differences in the value of different grades of hogs. Perhaps nothing much more can be done until a definite set of carcass grade specifications have been worked out and set up. We cannot measure price spreads between grades until we know what the grades are and how much heterogeneity there is in the hogs they cover.

Some idea of the price spreads to be expected may be gained from a comparison of our hogs with Canada's. Canada has pretty well standardized on the one type, the bacon type; and within that she has focused on the one breed, the Yorkshire. Our hogs are more heterogeneous. They range from moderate fat type (lard hog) to moderate meat type (bacon hog) and include several different breeds. The greater heterogeneity of our hogs by itself would result in wide price spreads between different grades; but it may be offset by other elements in the situation.

In Canada the differences between the values of different grades of hogs are considerable. The Canadians pay for No. 1 hogs a fixed premium of $1 per hog over the basic (No. 2) price, equivalent on the average to about 50 cents per 100 pounds. (Their hogs average in the neighborhood of 200 pounds live weight.) They also discount No. 3 hogs generally 50 cents per 100 pounds below the basic (No. 2) price.

It may be that grade differentials are large in Canada because a substantial percentage (about 35 percent) of the Canadian hogs are exported to Great Britain. It is well known that the British market is very discriminating, and some observers believe that the existence of this discriminating export market is the reason why substantial premiums are paid for quality hogs in Canada.

Exports of pork from the United States are unimportant; our pork business is largely domestic. Perhaps the American consumer is not so discriminating as the Britisher and will not pay much of a premium for quality. But Canadian authorities do not believe so. They claim that the domestic (Canadian) market pays just as large premiums and discounts as the British market and that some of the packers who like the carcass-selling system the best do a chiefly domestic business. If the domestic market in the United States is similar to the domestic market in Canada (which seems likely) the probabilities are that the grade differentials in the United States are similar to those which exist in Canada.

WOULD THE PRICE SPREADS BETWEEN GRADES PERSIST?

Another interesting point remains yet to be discussed. High-grade products are worth more, partly because they are scarce. If proper premiums were paid for high-grade hogs, and in response to those premiums farmers produced more high-grade hogs, would that not swamp the high-grade market and reduce the premiums that could be paid?

This point can be illustrated by reference to the butter industry. The stiuation is well presented in the following extract:

> "The Land O'Lakes Creameries, with 427 member creameries located in Minnesota and surrounding states, began to pay producers a premium of 3 cents per pound of butterfat for high-quality cream in the early twenties. In 1925 about two-fifths of the total production of these creameries was 93 score butter. Through continued use of premiums, this proportion of high-quality butter had increased to 74 percent by 1935. During the same period the production of butter scoring 90 or under decreased from 19 percent to 4 percent of the total . . .
>
> "Premiums paid by the Land O'Lakes Creameries from 1921-27 were made possible by higher market prices for high-quality butter, together with premiums obtained through

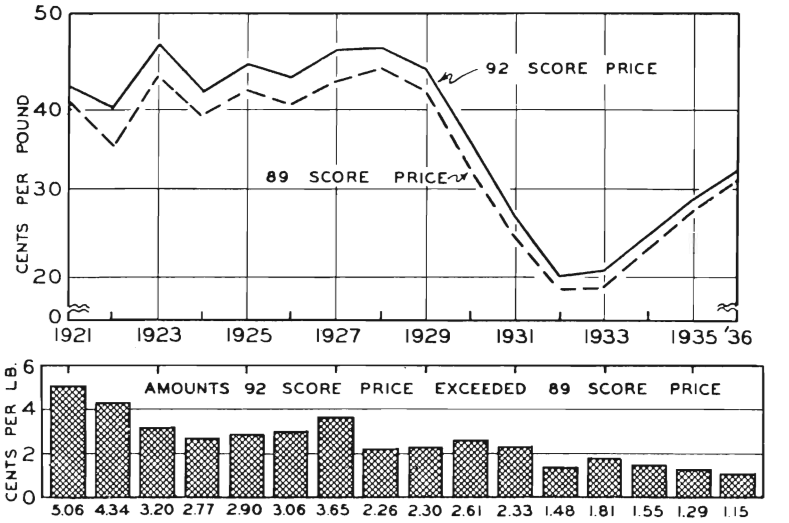

Fig. 15. Yearly average prices of 92-score and 89-score creamery butter at Chicago, and differences between those prices, 1921-1936.

> special market outlets. From 1921-1927 the price for 92 score butter on the Chicago market averaged 3.6 cents per pound higher than for 89 score (fig. 15). In later years, however, the spread between prices of 92 and 89 score butter averaged 2.4 cents per pound; and during 1932-1936, 1.4 cents. This decrease in price spread from 1937 to 1936 may be attributed to an increased volume of high-quality butter being marketed without a corresponding increase in demand."[24]

An opposite illustration is afforded by the beef cattle industry. Beef cattle have been sold by grade for years, and their prices are quoted by grades, as shown in fig. 16. The price spreads between these grades are large; they have persisted for years; yet they have not led to an increased production of the better grades and a narrowing of the price spreads similar to that which is shown in fig. 15 for butter. The price spreads for the different grades of beef cattle are still about as large as they ever were.

What lesson can be learned from these two diverse illustrations? Would the price spreads between different grades of hogs be likely to narrow like those for butter or stay wide like those for beef?

The answer hinges, perhaps, upon the nature of the commodity and the basis of its grades. This basis may be qualitative; it is in the case of butter. Taste, aroma, texture, color—these are the

[24] Illinois Farm Economics, University of Illinois, Urbana, Illinois. No. 24 and 25, May and June, p. 115. 1937.

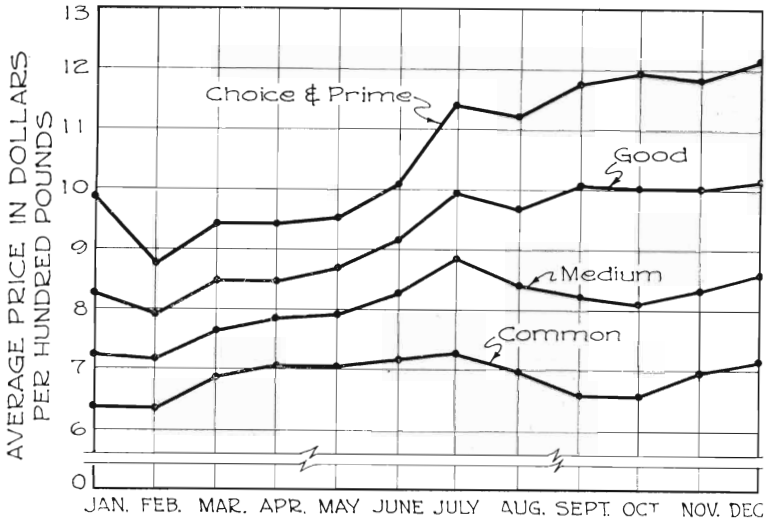

Fig. 16. Monthly average prices of four grades of beef cattle at Chicago, 1938.

chief things that determine the grade of butter. They are all qualitative, not quantitative. There are as many ounces of butter in a pound of 88 score butter as in a pound of 93 score butter; only the quality is lower. In that case it may be easy to swamp the high-quality market and reduce the price spreads between grades, because many people cannot afford to pay extra for high quality butter, even though they like it.

If, however, the basis of the grades of a product is quantitative, the situation is different. If there were only 12 ounces of butter in a pound of low-grade butter, while there were 14 ounces in a pound of high-grade butter, then (aside from quality differences) one would pay 14/12 (or 7/6) as much for the high-grade butter as for the low grade. And no amount of increased production of the high-grade butter could pull its price per pound down relative to the low-grade butter, because there would be more butter in each high-grade pound.

What about the basis of hog grades, then? Is it quantitative or qualitative? Of the three grade factors set forth several pages back (conformation, finish and quality), the first two are quantitative, while the third is qualitative. Conformation is a quantitative matter; it refers to the relative amount and shape of the different cuts. Finish (or amount and distribution of fat) is also quantitative. But quality is (as its name shows) qualitative; it covers color, texture, firmness, etc.

The Canadian carcass grades, as shown on p. 494, are primarily

quantitative; the specifications run almost entirely in terms of inches and pounds. The quantitativeness is complex, but basically it is similar to the hypothetical butter illustration given above. That is, a No. 1 carcass is worth more than a No. 2, chiefly because there is more of the right kind of meat on it. In that case, increasing the supply of No. 1 carcasses would have less effect on the price spread between No. 1 and No. 2 carcasses than if the grades were qualitative. The spreads would stay wide as they have in beef rather than narrowing as they have in the butter market.

The discussion so far has dealt with demand factors. Supply or cost factors would also exert an effect on price spreads between grades. If a substantial premium were paid for No. 1 grade hogs, that would provide an incentive for producing that grade only if the premium were greater than the extra cost of producing No. 1 hogs. Opinions differ as to how much more (if anything) it costs to produce high-grade hogs than low-grade hogs. Whatever the extra cost is, equilibrium would be reached when the prices of each of the different grades equaled the costs of producing each of them.

HANDLING BY INTERMEDIARY DEALERS

Another problem of an economic nature is the fact that many hogs do not go direct from the farmer to the packer but pass through one or more intermediary hands on the way. This extends the length of the channel along which identification has to be maintained.

One or two suggestions may be made concerning this problem. In the beginning stages of the adoption of carcass selling, it would be best adapted to the simplest kind of direct sale—where the hogs move direct from farmer to packer. The discussion in this bulletin has rested mainly on that basis, and the physical problems involved are shown to be capable of satisfactory solution under those simple conditions.

What complications are introduced when the hogs pass through the hands of an intermediary? We will consider the several different types of intermediary in order.

The simplest type is the packer-buyer located out in the country instead of at the plant. He is intermediary only in the physical handling sense. No complications arise in his case. He would buy hogs the same as at present, the only change being that he would pay for them on the basis of their carcass weight and grade instead of their live weight and grade. The only difference is that instead of saying, "I'll give you $7.50 per 100 pounds live weight," and waiting for the verdict of the scales as to their live weight, he would say, "I'll give you $10 per 100 pounds carcass weight," and wait for the verdict of the scales as to their carcass weight. The chief obstacle here would be the delay of a day or two in settlement. This

could be surmounted by paying 90 percent of the estimated value at once and the rest after the carcass value was determined.

Many hogs are sold through truckers. The trucker may have a definite "hook-up" with one packer, in which case the situation would be similar to that of the packer-buyer just discussed. If he is purely a hauler, taking the hogs wherever the farmer directs, he is merely the agent of the farmer, and the situation is the same as if the farmer trucked the hogs to the plant himself.

THE LOCAL BUYER

A more clearly separate intermediary is the independent local buyer. He makes his living by buying hogs as cheaply as he can and selling them wherever he can get the highest bid. Under the carcass system, he would buy hogs much as before. But he would bid so much per 100 pounds carcass weight, instead of so much per 100 pounds live weight as at present. He would carry his own tattooing iron with him and tattoo the hogs on the farm in the presence of the owner. He would then sell the hogs wherever he pleased, as before. His outlets would be limited to those packers who had carcass buying equipment, but this would be a handicap only in the early stages of adoption. No particular difficulty was experienced on this score in Canada.

Competition would force the local buyer to bid reasonable prices for hogs on the carcass basis the same as on the live weight basis. The only difference is that on the live weight basis, the weight of the hogs is determined on his scales; on the carcass basis, the weight of the carcasses is determined on the automatic carcass scales operating under continuous government supervision.

COMMISSION MEN

Another type of intermediary is the commission men at the terminal market. Consignment sales through these commission men would be carried on in much the same way on the carcass basis as on the present live weight basis. When hogs from several different farmers are combined in one carload, they are at present marked with paint or clippers, and returns are made accordingly. On the carcass basis they would be marked with a tattoo instead of a paintbrush and settled for on that basis.

The problem of the intermediary dealer, therefore, may turn out to be less troublesome than it appears at first. Hogs would be handled much the same on the carcass basis as on the live weight basis, as far as the dealers are concerned. This, in fact, has been found to be the case in actual practice in Canada. The carcass system provides for the accuracy of carcass selling with the minimum of change in existing trading practices. The scales are merely moved inside the plant, and a government man is put beside them.

FARMERS' BARGAINING POWER

A final question remains. Would carcass selling strengthen or weaken farmers' bargaining power in the sale of their hogs?

Bargaining power is one of the most controversial subjects in the field of marketing, and many erroneous statements have been made about it. In discussing bargaining power, we shall need to guard against misconceptions at every turn.

There are two kinds of bargaining power, and they are sometimes confused. One is the bargaining power that comes from control over the entire output. That sort of bargaining power can raise the price level of the commodity as a whole.

It is effected by reducing total production, as monopolies do. But that bargaining power would not be affected by changing the basis of sale from the live hog to the carcass, since that sort of change would have no necessary or direct connection with total production control.

The other kind of bargaining power is an individual matter. It would be affected by changing the basis of sale. Our discussion, then, will be focused upon this individual bargaining power.

It is an accepted axiom of trading that the more control you have over your product, the more individual bargaining power you have. Superficially, then, a system of sale for hogs which defers settlement until the hogs have left the sellers' hands entirely, and have in fact been killed and made into carcasses, might appear to weaken the sellers' bargaining power.

This superficial appearance, however, is misleading. The significant thing in any trade is not the time when settlement is made but the time when the *terms of settlement* are made. The significant thing is not when the check is made out but when the price per 100 pounds is settled.

Under the present system of selling hogs on the live weight basis, the farmer either telephones to the market ahead of time, describes his hogs, accepts a price for them and then sends the hogs in; or else he sends them in to market and accepts whatever price the market offers. In both cases the price is quoted as so many dollars and cents per 100 pounds live weight. The weight is settled by the scales at the buyer's yard.

Now if the hogs were sold by carcass weight, what change would that make in the situation? In the first case, the farmer would telephone in to the market and describe his hogs as before. A price would be bid and, after more or less argument, accepted. The price would be quoted in dollars and cents per 100 pounds carcass weight, instead of live weight, but otherwise the transaction would take place in the same manner as when hogs are sold by live weight. The hogs would then be sent in to the plant and slaughtered. The carcasses would be weighed and graded by a disinterested third party and the checks made out on that basis.

There is nothing in this procedure that would weaken the farmer's bargaining power compared with live weight selling. But there is something that would strengthen it. When hogs are described by the seller over the telephone, the description cannot be highly accurate, even if it is completely unbiased. The live hog defies accurate description. The buyer, accordingly, is always inclined to be on the safe side and quote a price that is a little lower than if the description were fully accurate. But when hogs are sold on the carcass basis, their description (as carcasses) is more accurate and unbiased than when they are sold on the hoof. The buyer can pay up closer to their full value, because that full value is more accurately ascertainable.

If the farmer sends his hogs in to market and takes whatever price the market affords, he places himself in a weak bargaining position on either the live hog or the carcass basis. But his position on the carcass basis is less weak than on the live weight basis, because the grade of his carcasses is impartially determined by a government grader, whereas on the live weight basis it is determined by one of the interested parties, the buyer.

It seems clear, then, that the farmers' bargaining power would be no weaker, and might be somewhat stronger, on the carcass basis than on the present live weight basis.

GENERAL CONCLUSION

As far as can be determined, packers would pay out about the same amount of money for a given year's supply of hogs under the carcass system of sale as they would under the present live weight system. If the carcass system were adopted, the benefits to hog producers would come not from any increase in the total amount of money for a given run of hogs, but from three other sources:

(1) The money paid for the hogs would be distributed more equitably among the different hog producers than at present. Each producer of high-yielding and high-grade hogs would get more than under the present live weight system, and the producer of low-yielding and low-grade hogs would get less.

(2) Under the stimulus of this incentive for raising high-yielding and high-grade hogs, with the passage of time hog producers would bring in hogs of higher average grade and yield than under the present system. A year's run of these higher grade hogs would be worth more to packers and would enable them to pay more money to hog producers.

(3) The carcass basis of sale would remove any incentive for "filling" hogs, and hog producers would save the cost of the feed now wasted on this practice.

Shifting the basis of sale from the live hog to the carcass and putting the carcass grading in government hands would involve

the minimum disturbance of existing livestock practices. It would simply mean moving the scales inside the plant and putting a government grader beside them. This would (1) protect farmers and others dealing with more experienced hog buyers, (2) remove the need for "higgling and bargaining" over the yield and grade of the carcass and (3) provide a uniform language for price quotations. By thus providing a clear, uniform and accurate language for buyers and sellers, it would sharpen and raise the plane of competition for hogs.

APPENDIX

The cut-out values of the college test hogs were based upon the individual weights and prices of the hams, bacons, picnics, loins, Boston butts, back fat, leaf lard, lean trimmings and jowls from one side of the carcass. This left several miscellaneous items—skull, feet, snouts, lips, kidneys, neck bones, spare ribs and tail. These items are small, and study of complete packer cut-out value tests show that they check out nearly constant. Accordingly, they were lumped together, and their total weight (usually about 10 pounds) was multiplied by a constant price, 5 cents per pound.

Whenever the average thickness of the back fat was more than 1.5 inches, the value of the back fat was computed on the basis of fat back prices; when the thickness was less than 1.5 inches, the back fat was thrown down into lard and its value computed on the basis of a yield of 75 percent and lard prices.

The weight and measurement data are available only for one side of the carcass, because the weighing and recording is a laborious job, and to save time, only one side of the carcass was cut. Study of the data shows, however, that taking one side only is not wholly satisfactory. It is difficult to split a carcass exactly down the center; accordingly, the weight of one side is often slightly more or less than half of the total carcass weight. The variation is not great (usually less than a pound), but in order to reduce its effect as much as possible, the cut-out value of the side is divided by the weight of that side (not multiplied by 2 and divided by the total carcass weight) to express the value as so much per 100 pounds carcass weight. This reduced the effect of the variation to the difference between (a) the value per pound of the particular piece of meat improperly split off (or on) the side, and (b) the average value per pound of the entire side.

It is believed that this procedure reduces the effect of the inaccurate splitting of the carcass to negligible proportions. In order to test this belief, the results of analyzing the 50 most accurately split carcasses are compared with the results of analyzing the 50 least accurately split carcasses. The differences in the results are well within the limits of sampling error, which shows that our procedure successfully reduced the effect of inaccurate carcass splitting to non-significance.

It is necessary to express the carcass values in terms of the live weight as well as the carcass weight. This is done by multiplying the value per 100 pounds carcass weight by the carcass yield (the percentage which the total carcass weight is of the total live weight).